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(54) **Process cartridge and image forming apparatus.**

(57) A process cartridge detachably mountable to a main assembly of an image forming apparatus includes an image bearing member ; a process device actable on the image bearing member ; and a developing bias conductive member for permitting developing bias voltage application to developing means ; grounding conductive member for electrically grounding the image bearing member ; wherein the conductive members are disposed adjacent an end of the image bearing member in a direction perpendicular to a movement direction of the image bearing member ; charging bias conductive member for permitting application of charging bias to the charging means, provided adjacent an opposite end of the image bearing member.

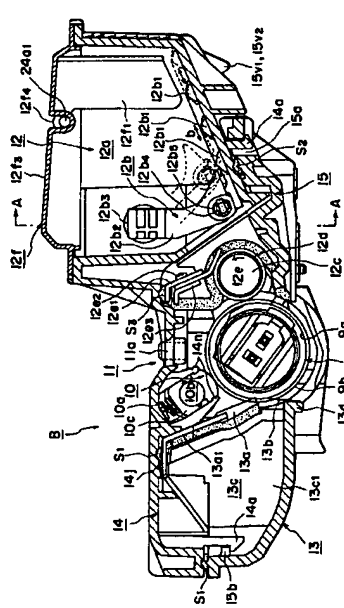

FIG. 3

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FIELD OF THE INVENTION AND RELATED ART

The present invention relates to a process cartridge and an image forming apparatus to which the process cartridge is detachably mountable.

The image forming apparatus includes a laser beam printer, LED printer, an electrophotographic copying machine, a facsimile machine and a word processor, for example.

In an image forming apparatus such as a printer, a uniformly charged photosensitive drum is selectively exposed to light so that a latent image is formed, and the latent image is visualized by toner into a toner image, which in turn is transferred onto a recording material. In such an apparatus, maintenance operations for various parts have to be performed by an expert service man with the result of inconveniences on the user side.

In view of this, a photosensitive drum, a charger, a developing device and a cleaning device or the like are unified into a cartridge. In this case, by loading the cartridge into a main assembly of the image forming apparatus by the user, replenishment of toner, exchange of parts such as image bearing member having reached the ends of service lives, are accomplished, thus facilitating the maintenance operations (process cartridge system). The process cartridge system is disclosed in U.S. Patents Nos. 3,985,436, 4,500,195, 4,540,268, 4,627,701 and so on.

With such a system, in order to provide high quality images, reliable electric connection established between the process cartridge and the image forming apparatus, has been desired. U.S. Patent No. 4,591,258 which has been assigned to the assignee of this application, has proposed that a contact for supplying voltage from the main assembly to a charger and a contact for supplying a voltage from the main assembly to a developing device, are disposed adjacent the same side as for receiving a driving force. In this structure, the photosensitive drum is grounded through a drum shaft. With this structure, when the process cartridge is inserted into the main assembly of the image forming apparatus along an axis of the photosensitive drum, mechanical connection for drive transmission and electrical connection between the main assembly and the process cartridge, are assuredly established. These structures are practically very effective in the case of a process cartridge which is mounted in a direction along the axis of the photosensitive drum to the main assembly of the image forming apparatus.

Japanese Laid-Open Patent Application No. 4253/1988 under the name of the assignee of this application has proposed a process cartridge having a mechanical drive receiving portion adjacent an end in a direction substantially perpendicular to a movement direction of the image bearing member and electric contact adjacent the other end. With this structure, the influence of the mechanical drive receiving portion to the electric contact can be reduced, and therefore, it is practically effective.

The present invention provides a further improvement.

It is a concern of the present invention to provide a process cartridge and an image forming apparatus capable of forming high quality images.

It is another concern of the present invention to provide a process cartridge and an image forming apparatus in which size of the process cartridge is reduced, and in which the size of the image forming apparatus is reduced.

It is a further concern of the present invention to provide improved process cartridge and image forming apparatus.

It is a yet further concern of the present invention to provide a process cartridge and an image forming apparatus capable of assured establishing electric contact with a main assembly, when the process cartridge is mounted in a main assembly of an image forming apparatus.

It is a further concern of the present invention to provide a process cartridge and an image forming apparatus in which influence of a drive transmitting portion to an electrically conductive member is reduced.

It is a further concern of the present invention to provide a process cartridge and an image forming apparatus in which liability of damage to an electric contact can be avoided.

It is a further concern of the present invention to provide a process cartridge and an image forming apparatus in which wiring distance of electrically conductive member for developing bias and an electrically conductive member for charging bias, can be reduced.

It is a further concern of the present invention to provide a process cartridge and an image forming apparatus in which electric power supply system for the process cartridge is simplified, and the structure of electric contacts is not easily influenced by the mounting operation of the process cartridge, while size and cost of the process cartridge and the image forming apparatus are reduced.

According to an embodiment of the present invention, a developing bias voltage application to developing means, charging bias voltage application to charging means and electric grounding of the image bearing member, can be assuredly carried out, and therefore, high quality of the image can be assured. In an embodiment of the present invention, an electrically conductive member for supplying developing bias voltage and an electrically conductive member for grounding, are provided adjacent the same end portion of the image bearing member in a direction substantially perpendicular to a movement direction of the image bearing member, and an electrically conductive member for supplying the charging bias vol-

tage is provided adjacent the opposite side. Because of this structure, mutual influence can be reduced.

According to an aspect of the present invention, a drive transmission mechanism is disposed adjacent to the opposite end, and therefore, the influence of the drive transmitting portion to the electrically conductive members, can be reduced.

According to a further aspect of the present invention, the positions of contacts with the electrically conductive members of the main assembly, are so located that they are not overlapped in the mounting direction of the process cartridge relative to the main assembly of the image forming apparatus.

Accordingly, the contact position of the conductive member is not damaged by the mounting on the process cartridge. According to a further aspect of the present invention, an electrically conductive member for supplying the developing bias voltage is provided adjacent the developing means, and an electrically conductive member for supplying a charging bias voltage is provided adjacent cleaning means. Accordingly, the wiring distance can be reduced.

These and other concerns, features and advantages of the present invention will become more apparent upon a consideration of the following description of the preferred embodiments of the present invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a sectional view of a laser printer, an exemplary mode of an image forming apparatus, showing its general structure containing a process cartridge.

Figure 2 is oblique external view of a laser printer.

Figure 3 is a sectional view of the process cartridge illustrated in Figure 1.

Figure 4 is an oblique external view of the process cartridge.

Figure 5 is an oblique external view of the process cartridge, as seen from the bottom side.

Figure 6 is a sectional view of the process cartridge, being separated into the top and bottom frames.

Figure 7 is an oblique internal view of the bottom frame.

Figure 8 is an oblique internal view of the top frame.

Figure 9 is a sectional view of a photosensitive drum.

Figure 10 depicts the flange gear portion attached to one of the end portions of the photosensitive drum.

Figure 11 is an oblique view of a drum ground contact.

Figure 12 is an oblique view of a drum ground contact.

Figure 13 is a partial cutaway view of the end portion of the photosensitive drum, showing an embodiment comprising a drum ground contact with no branch arm.

Figure 14 is a sectional view of the embodiment comprising the drum ground contact with no branch arm.

Figure 15 is an enlarged oblique view of the area adjacent to a drum axle.

Figure 16 is a schematic depiction of an operation for extracting a drum axle from the frame.

Figure 17 is an enlarged side view of a charging roller and adjacent essential components.

Figure 18 is an enlarged front view of a charging roller and adjacent essential components.

Figure 19 is an oblique view of a charging roller bearing.

Figure 20 is a sectional view of the process cartridge, at a line A-A in Figure 3.

Figure 21 is a sectional view of the process cartridge, at a line B-B in Figure 3.

Figure 22 depicts the positional relation between the photosensitive drum and developing sleeve, and of a method for pressing the developing sleeve.

Figures 23(a) and 23(b) are a cross-section at a line AA-AA and a cross-section at a line BB-BB, in Figure 22.

Figure 24 depicts how a conventional sleeve bearing slides.

Figure 25 depicts the engagement between the developing sleeve and sleeve gear.

Figure 26 is an oblique view of the tip wave of a receptor sheet.

Figure 27 depicts methods for pasting the receptor sheet.

Figure 28 depicts methods for pasting the receptor sheet.

Figure 29 is an oblique view of the receptor sheet.

Figure 30 depicts a method for pasting the receptor sheet.

Figure 31 depicts the state of contact between a cleaning blade supporting member and a rib provided on the top frame.

Figure 32 depicts the state of contact between a cleaning blade supporting member and a rib provided on the top frame.

Figure 33 is a normal distribution curve of average diameters of toner.

Figure 34 depicts an amount of blade invasion and a blade setting angle.

Figure 35 is a diagrammatic depiction of a method for measuring the blade contact pressure.

Figure 36 is a table showing the relation between the blade pressure and average particle diameter of the toner.

Figure 37 is an internal plan view of the bottom frame.

Figure 38 is an internal plan view of the top frame.

Figure 39 depicts how the bottom surface of the bottom frame is used to guide a recording medium.

Figure 40 is an oblique view of a shutter mechanism.

Figure 41 is an external side view of the process cartridge.

Figure 42 is an external bottom view of the process cartridge.

Figures 43(a) and 43(b) are a plan view of a shutter shaft retaining member, and an oblique view of the same.

Figure 44 is an external top view of the process cartridge.

Figure 45 depicts how the photosensitive drum is assembled in last.

Figure 46 depicts the toner adhesion to the end portions of the developing sleeve.

Figure 47 depicts the molded shape of the developing sleeve mounting surface.

Figure 48 is a sectional view of an embodiment in which a developing blade and a cleaning blade are pasted.

Figure 49 is a plan view of seal members disposed at the end portions of the cleaning blade.

Figure 50 depicts the relationship between the seal member disposed at the end portions of the cleaning blade, and the photosensitive drum.

Figure 51 depicts the condition of the lubricant coated on the seal members disposed at the end portions of the cleaning blade.

Figure 52 is a plan view of the seal members disposed at the end portions of the developing blade.

Figure 53 depicts the shape of the seal member disposed at one end of the developing blade.

Figure 54 is a schematic drawing for showing the locations where the guide members are attached when the photosensitive drum is assembled in the frame.

Figure 55 is a sectional view of a drum guide member disposed at one end of the blade supporting member.

Figure 56 schematically depicts lubricant at the contact surface between the cleaning blade and photosensitive drum.

Figure 57 depicts how the photosensitive drum bearing and the developing sleeve bearing are attached to the frame.

Figure 58 depicts how a cover film having a tear tape is pasted over a toner storage opening.

Figure 59 is an enlarged sectional view of the seal member pasted to the area through which the tear tape is pulled out.

Figures 60(a) and 60(ba) are a diagram for a process cartridge assembly-shipment line (a), and a diagram for a process cartridge disassembly-cleaning line (b).

Figure 61 depicts how the process cartridge is installed in the image forming apparatus.

Figure 62 depicts how the process cartridge is installed in the image forming apparatus.

Figure 63 depicts how the process cartridge is installed in the image forming apparatus.

Figure 64 depicts how the process cartridge is installed in the image forming apparatus.

Figure 65 depicts the positional state of the process cartridge in the image forming apparatus.

Figure 66 is a positional diagram for the gear and electrical contacts, which are attached to the photosensitive drum.

Figure 67 depicts forces exerted on the process cartridge.

Figure 68 depicts a rotational moment about a projection on the process cartridge side.

Figure 69 depicts the state of the process cartridge when a top lid is open.

Figure 70 depicts how the top and bottom frames are separated.

Figure 71 is a plan view and a sectional view, of an alternative embodiment of the flange gear attached to one end of the photosensitive drum.

Figure 72 is a schematic sectional view of alternative embodiments of the drum axle according to the present invention.

Figure 73 is an oblique views of alternative embodiments of the sliding bearing according to the present invention.

Figure 74 is an oblique views of alternative embodiments of the sliding bearing according to the present invention.

Figure 75 depicts an alternative embodiment of the cleaning means according to the present invention.

Figure 76 depicts an alternative embodiment of the cleaning means according to the present invention.

Figure 77 depicts an alternative embodiment of the cleaning means according to the present invention.

Figure 78 depicts an alternative embodiment of the cleaning means according to the present invention.

Figure 79 depicts an alternative embodiment of the cleaning means according to the present invention.

Figure 80 depicts an alternative embodiment of the cleaning means according to the present invention.

Figure 81 depicts an alternative embodiment of the cleaning means according to the present invention.

Figure 82 depicts an alternative embodiment of the cleaning means according to the present invention.

Figure 83 depicts an alternative embodiment of the cleaning means according to the present invention.

Figure 84 depicts an alternative embodiment comprising a locking mechanism for locking the shutter mechanism in the open state.

Figure 85 is an oblique view of an image forming apparatus comprising an alternative embodiment of a pressuring structure based on the shutter mechanism, and a process cartridge for such an apparatus.

Figure 86 is an oblique view of an image forming apparatus comprising an alternative embodiment of a pressuring structure based on the shutter mechanism, and a process cartridge for such an apparatus.

Figure 87 is a plan view and a side view of the alternative embodiment of the pressuring structure based on the shutter mechanism, depicting the initial stage of the cartridge installation into the image forming apparatus.

Figure 88 is a plan view and a side view of the alternative embodiment of the pressuring structure based on the shutter mechanism, depicting the stage at which the cartridge mains assembly has been pulled out of the case.

Figure 89 is a plan view of a locking lever mechanism of the alternative embodiment of the pressuring structure based on the shutter mechanism.

Figure 90 depicts positions of the locking lever in the alternative embodiment of the pressuring structure based on the shutter mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1

Referring to drawings, a process cartridge according to the first embodiment of the present invention, and an image forming apparatus comprising such a process cartridge will be described in more concrete terms.

{General Description of Process Cartridge and Image Forming Apparatus Comprising Process Cartridge}

First, the overall structure of the image forming apparatus will be described. Figure 1 is a sectional view of a laser printer comprising a process cartridge, illustrating its general structure. Figure 2 is an oblique external view of such a laser printer.

Referring to Figure 1, this image forming apparatus A comprises an exchangeable process cartridge B, which is disposed in a cartridge installation space 2 within a main assembly 1 of the apparatus. The process cartridge B comprises an image bearing member and at least one processing means. Within the apparatus main assembly 1, an optical system 3 is disposed in the upper portion, and a cassette 4 is disposed in a cassette installation space la located at the bottom. The optical system 3 projects the light beam carrying the imaging information provided by an external apparatus or the like, onto the image bearing member within the process cartridge B, and the cassette 4 holds recording medium. The recording medium within the cassette 4 is dispensed one by one by a recording medium conveying means 5. Also within the apparatus main assembly 1, a transferring means 6 is disposed so as to face the image bearing member of the installed process cartridge B. The transferring means transfers an image, which is formed on the image bearing member and developed by a developer (hereinafter, toner), onto the recording medium. On the downstream side of the transferring means 6 relative to the direction in which the recording medium is conveyed, a fixing means 7 is disposed, which fixes the toner image having been transferred onto the recording medium. The recording medium on which the toner image has been fixed is discharged by the conveying means 5, out into a discharge tray 8 located at the upper portion of the apparatus.

{Image Forming Apparatus}

Next, the structure of the image forming apparatus A will be described with regard to the optical system 3, recording medium conveying means, transferring means 6, and fixing means 7, in this order.

(Optical System)

The optical system projects the light beam carrying the imaging information provided by the external apparatus or the like, onto the image bearing member. As shown in Figure 1, it comprises a scanner unit 3e and a mirror 3f, which are disposed in the apparatus main assembly 1, wherein the scanner unit 3e comprises a laser diode 3a, a polygon mirror 3b, a scanner motor 3c, and an image forming lens 3d.

When an imaging signal is sent in by an external equipment such as a computer or word processor, the laser diode 3a emits light in response to the imaging signal, and the emitted light is projected as the imaging beam to the polygon mirror 3b, which is being rotated at a high speed by the scanner motor 3c. The imaging beam reflected by the polygon mirror 3b is projected through the image forming lens 3d and is reflected by the mirror 3f onto the image bearing member, exposing selectively the surface of the image bearing member. As a result, a latent image according to the imaging information is formed on the image bearing member.

In this embodiment, the scanner unit 3e is slightly inclined upward so that the light beam transmitted through the image forming leans 3d is projected slightly upward toward the mirror 3f. The scanner unit 3e which is the projecting means of the laser beam is provided with a laser shutter 3g which takes a closed

position (position indicated by a double dot chain line in Figure 1) at which it blocks the laser beam passage to prevent the laser beam from being unintentionally leaked, and a opened position (position indicated by the solid line in the figure) to which it retracts from the closed position to unblock the laser beam passage when the scanner is in use.

(Recording Medium Conveying Means)

The recording medium feeding means 5 feeds one by one the recording medium contained in the cassette 4 to an image forming station, and also, to the discharge tray 8 through the fixing means 7. The cassette 4 is placed in a manner so as to extend across substantially the entire length of the bottom portion of the apparatus main assembly 1. It can be pushed into or pulled out of the cassette installation space 1a of the apparatus main assembly 1, by a handle 4a, from the front side of the apparatus main assembly 1, in the direction indicated by an arrow a. The cassette 4 comprises a load plate 4c being pressed upward by a spring 4d in a manner so as to pivot about a shaft 4b. As the recording medium is mounted on this load plate 4c, the leading end of the recording medium, relative to the direction in which the recording medium is conveyed, comes in contact with a separating claw 4e.

After the cassette 4 is installed, the recording medium in the cassette 4 is separated one by one from the top and is conveyed out of the cassette 4, by a rotating pickup roller 5a. The recording medium conveyed out of the cassette 4 is further conveyed through a first reversing sheet path comprising a reversing roller 5b, a guide 5c, roller 5d and the like, to be delivered to the image forming station. Then, the recording medium is fed into a pressure nip formed by the image bearing member and the transferring roller 6 in the image forming station. In this pressure nip, the toner image having been formed on the surface of the image bearing member is transferred onto the recording medium. The recording medium having received the toner image is guided by a cover guide 5e and is delivered to the fixing means 7, where the toner image is fixed on the recording medium. After passing through the fixing means 7, the recording medium is delivered by way of a relay roller 5f to a bow-shaped second reversing path 5g. While passing through this second reversing path 5g, the recording medium is again reversed, and is discharged by a pair of rollers 5h and 5i from a discharge opening 8a, into the discharge tray 8 disposed above the scanner unit 3e and the installed process cartridge B.

The recording medium conveyance path in this embodiment has the so-called S-shape made up by the first and second reversing paths. This arrangement not only makes it possible to reduce the space occupied by this apparatus, but also, accumulates the recording medium in the discharge tray 8, in the normal numerical order, with its image carrying surface facing downward.

(Transferring Means)

The transferring means 6 transfers the toner image formed on the image bearing member in the image forming station, onto the recording medium. The transferring means 6 of this embodiment comprises a transferring roller 6, as shown in Figure 1. The transferring roller 6 presses the recording medium onto the image bearing member of the installed process cartridge B. With the recording medium being pressed upon the image bearing member, a voltage having the polarity opposite to that of the toner image is applied to the transferring roller 6, whereby the toner image on the image bearing member is transferred onto the recording medium.

The transferring roller 6 is supported by a bearing 6a loaded with the pressure from a spring 6b, whereby it is pressed upon the image bearing member. On the upstream side of the transferring roller 6, relative to the recording medium conveyance direction, there is a guide member 6c, which stabilizes the recording medium as the recording medium enters into the nip between the image bearing member and the transferring roller 6, and at the same time, shields the surface of the transferring roller 6 to prevent the toner from being scattered. After being passed through the nip between the image bearing member and transferring roller 6, the recording medium is conveyed in the downward direction, holding an angle of approximately 20 degrees, relative to the horizontal direction, so that it can be surely separated from the image bearing member.

(Fixing Means)

The fixing means 7 fixes the toner image, which has been transferred onto the recording medium by the voltage application to the transferring roller 6. Its structure is as shown in Figure 1. In the fixing means 7, a reference numeral 7a designates a heat resistant film guide member shaped like a trough, the cross section of which forms a substantial semicircle. On the under side surface of this guide member 7a, a low thermal capacity ceramic heater 7b of a flat plate shape is disposed, extending along the approximate longitudinal center line. Further, around the guide member 7a, a cylindrical (endless) thin film 7c of heat resistant resin is loosely fitted. This film 7c comprises three layers: an approximately 50 μm thick polyimide base film, an approximately 4 μm thick primer layer, and an approximately 10 μm fluorine coat layer. The base layer material has a high tensile strength and it is thick enough to withstand the stress or wear inflicted upon the film. This primer layer is made of a mix-

ture of PTFE, PFA, and carbon; therefore, it is electrically conductive.

Also on the under side of the guide member 7a, a pressure roller 7d is disposed in contact with the ceramic heater 7b, with constant pressure provided by a spring (not shown), and the film 7c being interposed. In other words, the ceramic heater 7b and pressure roller 7d form a fixing nip, with the film 7c being interposed. The pressure roller 7d comprises a metallic core and soft silicone rubber, and the silicone rubber is fluorine coated on its peripheral surface.

The ceramic heater 7b generates heat when supplied with electricity, and is controlled to keep a predetermined fixing temperature, by a temperature control system of a central control portion. The pressure roller 7d is rotated counterclockwise as indicated by an arrow in Figure 1, at a predetermined peripheral velocity. As the pressure roller 7d is rotatively driven, the cylindrical film 7c is clockwise rotated at a predetermined peripheral velocity around the film guide member 7a as indicated by the arrow mark in Figure 1, by the friction between the roller 7d and film 7c, through the fixing nip, remaining tightly in contact with and sliding on the downward facing surface of the ceramic heater 7b.

After undergoing the image transfer process, the recording medium is delivered to the fixing means 7, where it is guided by an entrance guide 7f into the fixing nip formed between the temperature controlled ceramic heater 7b and pressure roller 7d. In the fixing nip, the recording medium is fed between the cylindrical film 7c which is being rotatively driven, and pressure roller 7d, and is passed through the nip together with the film in a manner of being laminated together, remaining tightly pressed upon the downward facing surface of the ceramic heater 7b, with the film 7c being interposed.

While passing through the fixing nip, the unfixed toner image on the recording medium receives, through the film 7c, the heat from the ceramic heater 7b, whereby the toner image is thermally fixed on the recording medium. After coming out of the fixing nip, the recording medium is separated from the surface of rotating film 7c, is guided by an exit guide 7g, is further conveyed by the relay roller 5f, is passed through the second reversing sheet path 5g, and is discharged into the discharge tray 8 by the discharging roller pair 5h and 5i.

(Process Cartridge)

Next, the structures of the various portions of the process cartridge B to be installed in the image forming apparatus A will be described. Figure 3 is a sectional view of the process cartridge, showing its structure. Figure 4 is an oblique external view of the process cartridge. Figure 5 is an oblique external view of the process cartridge, as seen with bottom side facing upward. Figure 6 is a sectional view of the process cartridge which has been separated into top and bottom portions. Figure 7 is an oblique internal view of the bottom half of the cartridge. Figure 8 is an oblique internal view of the top half.

This process cartridge B comprises an image bearing member and at least one processing means. As for the processing means, there are, for example, a charging means for charging the surface of the image bearing member, a developing means for forming a toner image on the image bearing means, a cleaning means for cleaning the residual toner from the image bearing member surface, or the like. The process cartridge B of this embodiment comprises a electrophotographic photosensitive drum 9 as the image bearing member, a charging member 10, a developing means 12 containing the toner (developer), and cleaning member 13, wherein the photosensitive drum 9 is surrounded by the rest of the processing means as shown in Figures 1 and 3. These processing means are integrally contained in a housing made up of the top and bottom frame members 14 and 15, forming thereby an exchangeable cartridge which can be installed into or taken out of the apparatus main assembly 1.

In the top frame member 14, the charging means 10, an exposing means 11, and the toner storage of the developing means 12 are contained as shown in Figures 6 and 8, and in the bottom frame member 15, the photosensitive drum 9, the developing sleeve of the developing means 12, and the cleaning means 13 are contained as shown in Figures 6 and 7. Next, the structures of the various portions of the process cartridge B will be described in detail, with reference to the photosensitive drum 9, charging means 10, exposing means 11, developing means 12, and cleaning means 13, in this order.

(Photosensitive Drum)

<Structure of Photosensitive Drum)

The photosensitive drum 9 of this embodiment is 24 mm in external diameter and comprises an electrically conductive base member 9a made of a cylindrical piece of approximately 0.8 mm thick aluminum, and an organic semiconductor (OPC) coated as the photosensitive layer on the peripheral surface of the electrically conductive base member 9a. The photosensitive drum 9 is rotated for an image forming operation by the driving force transmitted to a flange gear affixed to one end of the drum 9, from an unshown driving motor, wherein the other end of the drum 9 is open. This open end of the drum 9 is supported by a bearing 16a of a bearing member 16.

<Flange Gear>

The flange gear comprises two gears, a helical gear 9c1 disposed on the outward side and a spur gear 9c2 disposed on the inward side, and is fixed to the left end (driving side) of the photosensitive drum 9, relative to the direction in which the recording medium is conveyed. This flange gear 9c is integrally molded of plastic material by injection molding.

As to the material for the flange gear 9c, polyacetal having slippery properties is used in this embodiment, but ordinary polyacetal or fluorinated polycarbonate may be used.

With regard to the flange gear 9c, the helical gear 9c1 on the outward side and spur gear 9c2 on the inward side have different diameters, and in the case of this embodiment, the diameter of the helical gear 9c1 on the outer side is formed larger than that of the spur gear 9c2 on the inner side. Also, the helical gear 9c1 is wider and has a larger number of teeth than the spur gear 9c2; therefore, even when a heavy load is imparted on the flange gear 9c, the driving force from the main assembly can be reliably transmitted to rotate the photosensitive drum 9, and also, to stably rotate the gear engaged with this gear 9c, by transmitting a large driving force.

The spur gear 9c2 is engageable with a gear provided in the main assembly to transmit driving force for rotating the transfer roller.

Given below are data of the exemplary gears. However, the present invention is not limited to the examples.

(1) External diameter of helical gear 9c1 (z1): approx. 28.9 mm
(2) External diameter of spur gear 9c2 (z2): approx. 26.1 mm
(3) Tooth width of helical gear 9c1 (z3): approx. 7.7 mm
(4) Tooth width of spur gear 9c2 (z4): approx. 4.3 mm
(5) Number of teeth of helical gear 9c1 (z5): 33
(6) Number of teeth of spur gear 9c2 (z6): 30
(7) Module of helical gear 9c1 (z7): 0.8
(8) Module of helical gear 9c2 (z8): 0.8
(9) Helix angle and direction of helical gear 9c1: right, 14.6°

As stated hereinbefore, the flange gear 9c comprises two gears 9c1 and 9c2 disposed side by side and is made of plastic material by injection molding, having been hollowed out below the tooth bottom; therefore, the flange gear 9c is weak against a force exerted in the radial direction, being likely to be deformed by the load imparted upon it as the driving force is transmitted.

Therefore, in order to prevent this deformation, a reinforcement member 9c4 is press-fitted in a hollowed portion 9c3 of the flange gear 9c. The reinforcement member 9c3 is preferred to be press-fitted into the hollowed portion 9c3 at the outer periphery as well as the inner periphery. According to a test conducted by this inventor, the press-fitting degree was preferred to be set in a range of 0 - 50 µm. This is because the gear tip circle diameter expands, or the like problem occurs, when the press-fitting condition is larger than the one in the aforementioned range, and also, because a condition less than the one in the aforementioned range is not so effective for increasing the gear strength.

It has been confirmed by a test that the pitch irregularity, which appears in the image corresponding to the pitch of the drum gear (flange gear 9c), can be eliminated by press-fitting the reinforcement member 9c4 in the hollowed portion 9c3 of the flange gear 9c.

Next, as to the means for affixing the flange gear 9c to the photosensitive drum 9, the photosensitive drum 9 and flange 9c are connected by crimping the edge of the photosensitive drum 9a at a portion 9a1 (two locations) onto a groove 9c5 of the flange gear 9c by a special tool. In this embodiment, the crimping is done at two locations, but the number of crimping locations is not limited to two. The essential thing is that the two components must be fixed to each other firmly enough to overcome the load imparted upon the flange gear 9c. By adopting this fixing means, the prior fixing means, which has been rather unreliable because of the use of glue, can be replaced by the more reliable mechanical fixing means.

<Ground Contact for Drum>

Referring to Figure 9, the photosensitive drum 9 of this embodiment is grounded by placing an electrically conductive ground contact 18a in contact with the internal peripheral surface of the drum 9. This ground contact 18a is disposed so as to contact the photosensitive drum 9 on the upper internal surface and on the side opposite to where the flange gear 9c is attached.

The ground contact 18a is made of electrically conductive material such as stainless steel spring material, phosphor bronze spring material, or the like, and is attached to a bearing member 16 which rotatively supports the photosensitive drum 9, on the side by which the drum is not driven. More specifically describing its structure, referring to Figure 11, holes 18a2 are cut through a base 18a1 for press-fitting around a boss provided on the bearing member 16. The base extends into two arms 18a3, at the end of each of which a semispherical projection is provided. These projections are disposed at different locations of their arms and project toward the back side of Figure 11.

As the bearing member 16 is attached to the photosensitive drum 9, the projections 18a4 of this

ground contact 18a are pressed upon the internal surface of the photosensitive member 9 by the elastic force of the arms 18a3. Having two or more locations (two in this embodiment) where contact is made with the photosensitive drum 9, the reliability of the ground contact 18a is improved, and also, the formation of the semispherical projections 18a4 as the actual contact points further stabilizes the contact between the photosensitive drum 9 and the contact point 18a.

In the case of the ground contact 18a described in the foregoing, the lengths of the arms 18a3 are the same and only the locations of the semispherical projections 18a4 are different, but instead, the lengths of the arms 18a3 of the ground contact 18a may be changed as shown in Figure 12. This arrangement causes the contact points between the semispherical projections 18a4 and photosensitive drum 9 to be displaced from each other in the circumferential direction; therefore, even when a small imperfection or the like is extending on the internal surface of the photosensitive drum 9, in the longitudinal direction of the drum 9, it does not happen that both semispherical projections 18a4 ride on the imperfection at the same time. As a result, the photosensitive drum 9 is even more reliably grounded. However, in the case of the latter arrangement, the difference in arm length causes the amount of arm deformation to be different between two arms 18a3, causing thereby the contact pressure to be different between the two contact points where the projections 18a4 make contact with the internal surface of the photosensitive drum 9, but this can be easily corrected by differentiating the bending angle between the arms 18a3.

As described in the foregoing, the ground contact 18a of this embodiment has two arms 18a3, but the number of arms 18a3 may be three or more, or just one (no branching) as shown in Figures 13 and 14, as long as the ground contact 18a reliably makes contact with the photosensitive drum 9. Further, a ground contact 18a which does not have such a semispherical projection or projections as described in the foregoing may be used.

When the contact pressure with which the ground contact 18a contacts the internal surface of the photosensitive drum 9 is too weak, the semispherical projection 18a4 cannot follow microscopic irregularities on the internal surface of the photosensitive drum, being likely to cause contact failure, and also, being likely to generate noises by vibrating the arm 18a3. In order to prevent this contact failure and vibration noise, the contact pressure must be increased, but unless the contact pressure is properly increased, the internal surface of the drum is scarred by the semispherical projection 18a4 while the image forming apparatus is operated for an extended period of time. Then, as the semispherical projection 18a4 rides on the thus created scars, vibration is generated, which sometimes effects the contact failure or vibration noise.

Taking these factors into consideration, the contact pressure between the internal surface of the photosensitive drum 9 and the drum grounding contact 18a is preferred to be set in a range of 10 - 200 g. According to a test conducted by this inventor, when the contact pressure was 10 g or less, contact failure was likely to occur as the photosensitive drum 9 rotated, generating electromagnetic waves which interfered with other electronic apparatuses, and when the image forming apparatus was used for an extended period of time with a contact pressure of 200 g or higher, the internal surface of the photosensitive drum 9 was scarred where the ground contact 8a slid, being likely to cause strange noises or contact failure as the photosensitive drum 9 rotated.

There are cases in which, because of the internal surface condition of the photosensitive drum 9, noise or the like cannot be completely eliminated. Nevertheless, the scarring or contact failure can be more surely prevented by applying electrically conductive grease to the internal surface of the drum, on the areas where the ground contact 18a slides.

As for the contact location where the ground contact 18a contacts the internal surface of the photosensitive drum 9, it is preferred to be on the upper side (substantially diametrically opposed from the transfer roller 6) of the internal surface of the drum 9, as shown in Figure 3. This is because, as the photosensitive drum 9 is driven, it is imparted with a force directed toward the transferring roller 6 and this force is likely to be displaced by the amount of tolerance (or wear) toward the transferring roller 6. Therefore, the contact between two components becomes more reliable by disposing the ground contact 18a so as to contact the upper side of the internal surface of the drum.

<Drum Axle>

Referring to Figure 9, the photosensitive drum 9 is rotatively supported by a metallic drum axle 9d on the driven side and by a bearing 16a of the bearing member 16 on the non-driven side. Next, referring to Figure 15, the drum axle 9d is press-fitted in the axle hole 15s cut in the bottom frame 15 which houses the photosensitive drum 9, with a press-fitting condition of no more than 47 μm, and then, is inserted in the axle hole of the flange gear 9c affixed to the end of the photosensitive drum 9, supporting thus rotatively the drum 9. By press-fitting the drum axle 9d into the axle hole 15s of the bottom frame 15, the drum 9 can be supported without using a machine screw for affixing the drum axle 9d to the bottom frame 15. Therefore, this arrangement has such advantages that it does not happen that the bottom frame 15 becomes unrecyclable because the machine screw hole for affixing the drum axle has become too large, and also,

that the tolerance of the drum axle 9d can be reduced so as for the photosensitive drum 9 to be more smoothly rotated in order to produce more precise images, that is, high quality images.

On one of the end surfaces of the drum axle 9d (surface exposed outward the process cartridge B), a screw hole 9d1 is drilled, which makes it easier to remove the press-fitted drum axle 9d when the process cartridge B is taken apart during the recycling. The material for the drum axle 9d may be either metal or plastic. The screw hole 9d1 has a female thread, is drilled in parallel to the orientation of the axle 9d, and is positioned approximately at the center of the end surface of the axle 9d.

Referring to Figure 16, an example of operation for extracting the drum axle 9d from the bottom frame 15 will be described. An extracting tool 19 for extracting the drum axle 9d comprises a shaft 19a having an external diameter of approximately 4 mm, a weight 19b having an external diameter of approximately 40 mm and a thickness of approximately 10 mm, and a stopper 19a2 having an external diameter of approximately 10 mm, wherein the shaft 19a is threaded at one end 19a1, is passed through the center hole cut in the weight 19b, and is affixed to the stopper 19a2 at the other end. By screwing the threaded portion 19a1 of this extracting tool 19 into the screw hole 9d1 of the drum axle 9d having been press-fitted in the bottom frame 15, and then, thrusting several times the weight 19b against the stopper 19a2, the drum axle 9d can be easily extracted from the bottom frame 15. The threaded portion 19a1 is cut as the male thread so that it can be screwed into the screw hole 9d1 with the female thread.

In this embodiment, the screw hole to be used when the cartridge is disassembled during the recycling is described referring to a case in which the screw hole is drilled in the drum axle which is press-fitted into the hole of the cartridge frame. The hole drilling is not limited to this case alone; instead, such a hole may be drilled in other members to be press-fitted, so that they can be easily extracted.

(Charging Means)

<Structure of Charging Means>

The charging means is for charging the surface of the photosensitive drum 9. In this embodiment, the so-called contact charging method such as the one disclosed in Japanese Laid-Open Patent Application No. 149669/1988 is employed. More specifically, referring to Figure 3, a charging roller 10 is rotatively supported within the top frame 14 by a sliding bearing 10c. This charging roller 10 comprises a metallic roller shaft 10b (electrically conductive metallic core made of steel, SUS, or like material), an elastic rubber layer (made of EPDM, NBR, or like material) laminated on the roller shaft 10b, and a carbon-dispersed urethane rubber layer laminated over the elastic rubber layer, or it comprises a metallic roller shaft 10b and a carbon-dispersed, foamed urethane rubber layer coated on the roller shaft 10b.

The slide bearing 10c supporting rotatively the roller shaft 10b of the charging roller 10 is held by a slide bearing guide claw 14n in such a manner that it is allowed to slide slightly toward the photosensitive drum 9 (Figure 17(b)) without dropping out (Figure 17(a)). Further, the slide bearing 10c supporting rotatively the roller shaft 10b is pressed by a spring 10a toward the photosensitive drum 9, whereby the charging roller 10 remains in contact with the surface of the photosensitive drum 9.

<Sliding Distance of Charging Roller>

As described in the foregoing, the charging roller 10 is in contact with the surface of the photosensitive drum 9, whereby it rotates following the rotation of the drum 9 as the drum 9 is driven. When the photosensitive drum 9 is driven by a force transmitted from an unshown driving motor, the drum 9 is forced toward the transferring roller. In other words, the photosensitive drum 9 is slightly displaced in the direction away from the charging roller 10. More specifically, the photosensitive drum 9 is displaced more at the non-driven side than at the driven side, though by an extremely small amount. When this occurs, the amount of distance by which the charging roller 10 slides in the radial direction toward the photosensitive drum 10 sometimes fails to remain in pace with the amount of distance by which the photosensitive drum 9 is displaced, causing thereby the photosensitive drum 10 and charging roller 10 to be separated.

Therefore, in this embodiment, the distance that is allowed for the charging roller 9 to slide toward the photosensitive drum 9 in the radial direction is set up to be larger compared to that for the prior one. Further, the sliding amount of the charging roller 10 in the radial direction is differently set between its longitudinal right and left sides; more specifically, the sliding distance for the sliding bearing 10c at the non-driven side (power supply side) is set up to be larger than that at the driven side (non-power supply side). In this embodiment, referring to Figure 17, the sliding amount β for each sliding bearing 10c for the charging roller 10 is set up to be approximately 1.5 mm on the non-driven side, and approximately 1.0 mm on the driven side. Further, in this embodiment, the sliding amount β for each sliding bearing 10c on the driven or non-driven side is set by changing, that is, by shortening, the distance between the mid point to a butting surface 10c3. In other words, when the charging roller 10 is installed in the top frame 14, the permissible amount of movement of the charging roller 10 in the direction (radial direction) perpendicular to the longi-

tudinal axis of the charging roller 10 is differently selected between on one side and the other side of the charging roller 10.

<Sliding Bearing>

The charging roller 10 and photosensitive drum 9 are more or less angularly disposed to each other because of the tolerance of related components including the components such as the top frame in which they are installed. Therefore, when the photosensitive drum rotates, the charging roller 10, the rotation of which is slaved to that of the photosensitive drum 9, is subjected to a thrust directed in the axial direction, being thereby pushed to one side; therefore, the roller shaft 10b sometimes butts against the side of the top frame 14, whereby the butted portion is shaved by friction. Also, during the shipment of the cartridge, the roller shaft 10b of the charging roller 10 butts the side wall of the top frame 14 because of the vibration or the like, whereby the butted portion is sometimes scarred. When these incidents occur, the roller shaft 10b of the charging roller 10 occasionally hangs up at the shaved or scarred portion, which breaks the contact between the charging roller 10 and photosensitive drum 10. As a result, defective images are produced. Further, the cartridge frames having been shaved or scarred may not be recyclable.

Therefore, in order to simplify the process for correcting the defects of the cartridge frames during manufacturing or recycling, a thrust regulating means for regulating the force directed in the axial direction of the charging roller 10 is integrally formed with the sliding bearing 10c which rotatively supports the roller shaft 10b, instead of being disposed in the top frame 14. In other words, a stopper 10c1 raked like a key is integrally formed, as the thrust regulating means, with each of the sliding bearings 10c, as shown in Figures 18 and 19. In this embodiment, the sliding bearing 10c on the power supply side (Figure 19(b)) is formed of electrically conductive resin material containing a large amount of carbon filler, and the one on the non-power supply side (Figure 19(a)) is formed of electrically non-conductive material such as polyacetal (POM).

Further, in order to prevent the slide guide claw 14n and sliding bearing 10c from being damaged when the process cartridge is dropped, or in the like situation, and the claw 14 and bearing 10c are subjected to a force in the thrust direction much larger than that to which the charging roller 9 is subjected when the photosensitive drum 9 is driven, pendent members 14p projecting downward from the top frame 14 are provided on the outward sides of the sliding bearings 10c, relative to the thrust direction.

All that is necessary for assembling the charging roller 10 into the top frame 14 is to, first, make the sliding bearing guide claw 14 support the sliding bearing 10c, with the spring 10a being interposed, and then, fit the roller shaft 10b of the charging roller 10 into the sliding bearing 10c. As this top frame 14 is combined with the bottom frame 15, the charging roller 10 comes to be pressed upon the photosensitive drum 9, as shown in Figure 3.

<Voltage Applied to Charging Roller>

During the image forming operation, the surface of the photosensitive drum 9 is uniformly charged by applying to the charging roller 10 being rotated by the rotation of the photosensitive drum 9, an oscillating voltage composed by superposing an AC voltage on a DC voltage.

To describe more precisely the voltage applied to the charging roller, the voltage applied to the charging roller 10 may be a pure DC voltage, but in order to charge uniformly the photosensitive drum 9, it is preferred to apply an oscillating voltage composed by superposing an AC voltage on a DC voltage. More preferably, the charge uniformity can be enhanced by applying to the charging roller 9 an oscillating voltage composed by superposing an AC voltage, having a peak-to-peak voltage more than twice the charge start voltage at which the charging starts when a pure DC voltage is applied, on a DC voltage (Japanese Laid-Open Patent No. 149669/1988). Here, an oscillating voltage means a voltage, the value of which periodically changes in relation to time, and is preferred to have a peak-to-peak voltage more than twice the charge start voltage at which the surface of the photosensitive drum begins to be charged when a pure DC voltage is applied. Its waveform is not limited to a sine waveform; instead, it may be in the form of a rectangular waveform, a triangular waveform, or a pulse waveform. However, from the standpoint of charging noise, a sine waveform which does not contain high frequency components is preferable. The oscillating voltage also includes a voltage having a rectangular waveform formed by turning periodically on and off a DC power source, or a like voltage.

<Power Supply Path to Charging Roller>

Next, a power supply path to the charging roller 10 will be described. Referring to Figure 18, one end portion 18c1 of an electrically conductive charge bias contact 18c is pressed upon an electrically conductive charge bias contact pin on the apparatus main assembly side, wherein the other end of this charge bias contact 18c contacts a spring 10a. The spring 10a is in contact with the sliding bearing 10c supporting rotatively one end (power supply side) of the roller shaft 10b. The power is supplied from the power source on the apparatus main assembly side to the charging roller 9, through a path established in the above described manner.

As described hereinbefore, the sliding bearing 10c on the power supply side of the charging roller 10 is formed of the electrically conductive resin material containing a large amount of carbon filler; therefore, the charge bias can be reliably applied through the power supply path described in the foregoing.

(Exposing Means)

An exposing means 11 exposes the surface of the photosensitive drum 9 having been uniformly charged by the charging roller 10, with a light beam from an optical system 3. As shown in Figures 1 to 3, the top frame 14 is provided with an opening 11a for allowing the laser beam reflected by the mirror 3f to be projected onto the photosensitive drum 9.

(Developing Means)

<Structure of Developing Means>

Referring to Figure 3, the developing means 12 for forming the toner image with use of the magnetic toner has the toner storage 12a for storing the toner, and in the toner storage 12a, a toner feeding mechanism 12b for feeding out the toner is provided. The toner fed out from the toner storage 12a forms a thin toner layer on the surface of a developing sleeve 12d containing a roller magnet having multiple magnetic poles as the developing sleeve 12d is rotated in the direction indicated by an arrow in the figure. While the toner layer is formed on the developing sleeve 12d, the toner is triboelectrically charged by the friction between the toner and the developing sleeve 12d as well as developing blade 12e, for developing the electrostatic latent image on the photosensitive drum 9. The developing blade 12e for regulating the thickness of the toner layer is attached to the bottom frame 15 so as to be held down on the surface of the developing sleeve 12d with a predetermined pressure.

<Developing Blade>

As for the construction of the developing blade, a plate-shaped blade cut out of flexible material such as polyurethane or silicone rubber is pasted to a supporting member 12e1 made of metallic plate, and the supporting member 12e1 is affixed, with a screw 12e2, on the attachment mount of the bottom frame 15, being precisely positioned so that the developing blade 12e rubs the developing sleeve with a predetermined pressure.

<Toner Feeding Mechanism>

Referring to Figure 13, the magnetic toner feeding mechanism 12b feeds the toner as an arm 12b2 is swung back and forth about the shaft 12b3, and thereby, a feeding member 12b1 connected to the arm 12b2 is moved back and forth in the direction indicated by an arrow B along the bottom surface of the toner storage 12b1.

The feeding member 12b1, arm 12b2, and shaft 12b3 are made of polypropylene (PP), acrylobutadiene styrene (ABS), high impact polystyrene (HIPS), or the like material, wherein the arm 12b2 and shaft 12b3 are integrally formed.

The feeding member 12b1 is a rod-like member, having a substantially triangular cross section, and is extended in the direction parallel to the rotational axis of the photosensitive drum 9. Several of the feeding members 12b1 are connected together to form an integral component for sweeping the entire bottom surface of the toner storage 12a.

The shaft 12b3 is integrally formed with a pair of arm members 12b2, with each arm member 12b2 projecting downward from the shaft 12b3, at a location a certain distance away in the longitudinal direction of the shaft 12b3 from the respective side wall of the toner storage 12a (Figure 20). In this embodiment, the arm members 12b2 are disposed no less than 15 mm away from the respective side walls of the toner storage 12a so that the toner in the toner storage 12a is not going to be compacted in the narrow spaces between the side walls and arm members 12b2. Further, when the toner storage 12a is entirely filled with the toner, the toner resistance against the toner feeding member 12b1 or arm member 12b2 is large, and the shaft 12b3 is sometimes twisted by the resistance, but by narrowing the distance between the arm members 12b2, the twist of the shaft 12b2 is reduced.

One end of the shaft 12b3 about which the arm members 12b2 swing is passed through the side wall of the toner storage 12a and is connected to a rotatively supported transmission member 17, and the other end is also rotatively supported by the bottom portion of a U-shape groove 12a1 within the toner storage 12a, being at the same time prevented by a rib 12f2 of the cover member 12f from being lifted (Figure 20). The transmission member 17 is constructed so as to be engaged with a transmitting means for transmitting a driving force when the process cartridge B is installed in the image forming apparatus A. The transmitting means 17 transmits the driving force for swinging the arm member 12b2 about the shaft 12b3 by a predetermined angle. This transmitting means 17 will be described later.

The feeding members 12b1 and arm member 12b2 are connected by engaging rotatively a pair of projections 12b4, provided apart from each other on one of the feeding members 12b1 at respective locations in the longitudinal direction of the feeding member 12b1, into an elongated hole 12b5 cut in the arm member 12b2. Though not illustrated, the structure described above may be constructed by forming integrally the feeding member and arm member so that

the connecting points can be bent with little resistance.

Having such a structure as described in the foregoing, as the arm member 12b2 is swung a predetermined angle during the image forming operation, the feeding member 12b1 is oscillated in the direction indicated by the arrow b along the bottom surface of the tone storage 12a, as illustrated by a solid line and a broken line in Figure 3, whereby the toner stored near the bottom of the toner storage 12a is conveyed toward the developing sleeve 12d. At this time, since the cross section of the feeding member 12b1 has a substantially triangular shape, the toner is conveyed as if being gently scraped by the angled surface of the feeding member 12b1.

Therefore, the magnetic toner is likely to be neither compacted near the developing sleeve 12d by being excessively conveyed, nor to run short by being insufficiently conveyed. As a result, the toner layer formed on the surface of the developing sleeve is not going to be easily deteriorated.

<Cover Member>

The upper opening portion of the toner storage 12a is covered with a cover member 12f welded to the opening portion. On the internal surface of the top plate of the cover member 12f, downward projections 12f1 are provided as shown in Figure 3. The distance between the bottom end of the downward projection 12f1 and bottom surface of the toner storage 12a is set to be slightly larger than the height of the triangular cross section of the tone feeding member 12b1. Therefore, as the feeding member 12b1 is lifted away from the bottom surface of the toner storage 12a, its movement is regulated by the downward projections 12f1. As a result, the toner feeding member 12b1 is floating up and down between the bottom surface of the toner storage 12a and downward projections 12f1, and is thereby prevented from being excessively lifted.

<Driving Force Transmitting means>

Next, a driving force transmitting means for transmitting the driving force to the toner feeding mechanism 12b will be described. Figure 20 is a sectional view of the process cartridge B shown in Figure 3, showing the section at a line A-A. Figure 21 is also a sectional view of the same process cartridge, showing in this case the cross section at a line B-B.

Referring to Figure 20, one end of the shaft 12b3 which is the fulcrum of the toner feeding mechanism 12b is passed through the side wall of the toner storage 12a of the top frame 14 and is connected to the rotatively supported transmission member 17. The transmission member 17 is made of resin material such as polyacetal (POM) or polyamide which excels in slippery properties, and is attached to the top frame member 14 by so-called snap-fit, in such a manner that it can freely rotate about the rotational axis of the shaft 12b3.

As for the driving force transmitting means, as shown in Figure 21, the helical gear 9c1 of the flange gear 9c attached to one end of the photosensitive drum 9 is engaged with the sleeve gear 12g of the developing sleeve 12d; the sleeve gear 12g is engaged with a stirring gear 20 provided with a boss 20a, which is integrally formed with the stirring gear 20 and is disposed on the side surface of the stirring gear 20, a predetermined distance away from the rotational center of the stirring gear 20; the boss 20a is engaged with the elongated hole cut in the arm member 17a of the transmitting member 17. With this structural arrangement in place, as the flange gear 9c rotates in the direction indicated by an arrow in the figure, the stirring gear 20 is rotated through the sleeve gear 12g in the direction indicated by an arrow in the figure, whereby the transmission member 17 is swung back and forth by the boss 20a of the stirring gear 20 in the direction indicated by an arrow in the figure, transmitting the driving force to the shaft 12b3 connected to the transmission member 17, and finally, the toner feeding mechanism 12b is driven.

<Positioning of Stirring Gear>

The positioning of the rotational axis of the stirring gear 20 is dependent on how an axle 20b of the stirring gear 20 is fitted into a U-shape groove 15p1 of a rib 15p formed on the bottom frame 15. Therefore, all that is needed to improve the accuracy of engagement between the stirring gear 20 and sleeve gear 12g is to form precisely the bottom frame 15. The upper side of the axle 20b of the stirring gear 20 is regulated by a concave guide 14i provided below the through hole cut in the top frame 14 which rotatively supports the transmission member 17. Therefore, as the top and bottom frames 14 and 15 are combined, the stirring gear 20 is rotatively supported and its position is fixed. By having such an arrangement, it becomes unnecessary to prepare a through hole for supporting rotatively the stirring gear 20, improving subsequently the strength of the cartridge frame.

<Developing Sleeve>

Next, the developing sleeve 12d on which the toner layer is formed will be described. The developing sleeve 12d and photosensitive drum 9 are disposed to face each other with a micro-gap (approximately 200 μm - 300 μm) between them. In this embodiment, in order to effect this micro-gap, a contact ring 12d1 having an external diameter larger by the above described micro-gap than that of the developing sleeve 12d is fitted on the developing sleeve 12d, toward

each axial end of the developing sleeve 12d, outside the range where the toner layer is formed, so that the ring 12d1 comes in contact with the photosensitive drum, outside the range where the latent image is formed.

Here, the positional relation between the photosensitive drum 9 and developing sleeve 12d will be described. Figure 22 is a longitudinal section for depicting the positional relation between the photosensitive drum 9 and developing sleeve 12d and a method for giving a pressure to the developing sleeve 12d. Figure 23(a) is a cross section taken along a line AA-AA in Figure 22, and Figure 23(b) is a cross section taken along a line BB-BB in Figure 22.

As shown in Figure 22, the developing sleeve 12d on which the toner layer is formed and the photosensitive drum 9 are positioned to face each other with the micro-gap (approximately 200 μm - 400 μm) between them. At this time, one end of the photosensitive drum 9 is rotatively supported by a drum axle 9d which is press-fitted in a shaft hole 15s of the bottom frame 15 and then, is fitted through the shaft hole of the flange gear 9c attached to one end of the photosensitive drum 9, and the other end is also rotatively supported by the bearing 16a of the bearing member 16 fitted fixedly in the same bottom frame 15. The developing sleeve 12d is fitted with the contact ring 12d1 having an external diameter larger by the above described micro-gap, toward each axial end of the developing sleeve 12d, outside the range where the toner layer is formed, so that the ring 12d1 comes in contact with the photosensitive drum, outside the range where the latent image is formed.

The developing sleeve 12d is rotatively supported by sleeve bearings 12h and 12i positioned toward respective axial ends, wherein the sleeve bearing 12h on one side (non-driven side) is located, relative to the axial direction, outside the toner layer formation range but inside the contact ring 12d1, and the sleeve bearing 12i on the other side (driven side) is located outside the toner layer formation range as well as outside of the contact ring 12d1. These sleeve bearings 12h and 12i are so attached to the bottom frame 15 that they can slightly slide in the direction indicated by an arrow in Figure 22. To the projections projecting from the sleeve bearings 12h and 12i, a pressure spring 12j is attached, being compressed against the wall of the bottom frame 15 and generating thereby the pressure for pressing the developing sleeve 12d toward the photosensitive drum 9. By the arrangement described in the foregoing, the contact ring 12d1 can remain in contact with the photosensitive drum 9, maintaining reliably the gap between the developing sleeve 12d and photosensitive drum 9, and also, the driving force can be reliably transmitted to the sleeve gear 12g of the developing sleeve 12d, which is engaged with the flange gear 9c and its helical gear 9c1.

<Sliding Amount of Developing Sleeve>

Referring to Figure 24, the direction in which the sleeve bearing 12h and 12i can slide will be described. To describe it, first, on the driving side of the developing sleeve, when the driving force is transmitted from the driving motor provided on the apparatus main assembly side to the helical gear 9c1 of the flange gear 9c, and then, from the helical gear 9c1 to the sleeve gear 12g, the operating pressure is directed away from the tangential line of the intermeshing pitch circle of the helical gear 9c1 and intermeshing pitch circle of the sleeve gear 12g, by the operating pressure angle (20° in this embodiment). Therefore, the operating pressure is directed as indicated by a arrow P in Figure 24 ($\theta \fallingdotseq 20°$). With the structural arrangement described hereinbefore, this operational pressure P is divided into a component Ps and a component Ph, which are parallel to and perpendicular to the sliding direction of the sleeve bearing 12h, respectively. When the sleeve bearing 12h is slid in a direction parallel to the straight line connecting the rotational center of the photosensitive drum 9 and that of the developing sleeve 12d, the components Ps parallel to the sliding direction is away from the photosensitive drum 9, as shown in Figure 24. Therefore, the gap between the photosensitive drum 9 and developing sleeve 12d tends to be easily changed by the operational pressure between the helical gear 9c1 of the flange gear 9c and sleeve gear 12g, whereby the toner on the developing sleeve 12d tends to fail to move properly onto the photosensitive drum 9. This may be liable to cause the deterioration of development performance.

Because of the reasons described in the foregoing, in this embodiment, how the driving force is transmitted from the helical gear 9c1 of the flange gear 9c to the sleeve gear 12g is taken into consideration, and as shown in Figure 23(a), the direction in which the sleeve bearing 12i on the driven side of the developing sleeve 12d (side where the sleeve gear 12g is attached) is allowed to slide is aimed as shown by an arrow Q in Figure 23(a). In other words, an angle ψ, which is formed by the direction of the operating pressure P between the helical gear 9c1 of the flange gear 9c and the sleeve gear 12g and by the slidable direction (arrow Q direction) of the driven side sleeve bearing 12i, is set to take an angle slightly larger (approximately 92° in this embodiment) than 90°. By this structural arrangement, the horizontal component Ps of the operating pressure P is reduced to substantially zero; in this embodiment, the component Ps works to force slightly the developing sleeve 12d toward the photosensitive drum 9. In such a case, the pressure imparted on the developing sleeve 12d by the compression spring 12j is increased by an amount a of spring pressure to keep constant the gap between the photosensitive drum 9 and developing sleeve 12d, so

that a proper developing operation can be carried out.

Next, the sliding direction of the sleeve bearing 12h on the non-driven side of the developing sleeve 12d (side where the sleeve gear 12g is not attached) will be described. Being different from the case on the driven side, the non-driven side is not subjected to the external force; therefore, the sliding direction of the sleeve bearing 12h is made substantially parallel to the straight line connecting between the centers of the photosensitive drum 9 and developing sleeve 12d, as shown in Figure 23(b).

As described in the foregoing, in this embodiment, when the developing sleeve 12d is directly pressed upon the photosensitive drum 9, the positional relation between the developing sleeve 12d and photosensitive drum 9 can be always kept proper by differentiating the direction in which the developing sleeve 12d is pressured, between on the driven side and on the non-driven side; therefore, a proper developing operation can be carried out.

Further, the slidable direction of the sleeve bearing 12i on the driving side may be made substantially parallel to the straight line connecting the centers of the photosensitive drum 9 and developing sleeve 12d, in the same manner as that of sleeve bearing 12h on the non-driven side. More specifically, in this embodiment, since on the driven side, the sliding direction component Ps of the operating pressure P between the flange gear 9c and sleeve gear 12g works to force the developing sleeve 12d to move away from the photosensitive drum 9, all that is needed is to increase the pressure of the compression spring 12j on the driven side by the amount equivalent to the component Ps, compared to that on the non-driven side, so that the developing sleeve 12d can be pressed to counter the component Ps. In other words, when the relation between a pressure P1 imparted upon the non-driven side of the developing sleeve 12d by the compression spring 12j and a pressure P2 generated by the compression spring 12j on the driven side is selected to satisfy an equation: $P2 = P1 + Ps$, the developing sleeve 12d always receives a proper pressure, guaranteeing the proper gap between the developing sleeve 12d and photosensitive drum 9.

<Stopper Projection for Sleeve bearing>

On the upper portion of the sleeve bearing 12i on the driven side of the developing sleeve 12d, a stopper projection 12i1 for preventing the sleeve bearing 12i from sliding out is provided, so that the developing sleeve 12d is prevented from being ejected out by compression spring 12j when the developing sleeve 12d is assembled into the apparatus. Since, as described hereinbefore, the pressuring direction of the compression spring 12j and sliding direction of the sleeve bearing 12i are different, a rotational moment in the clockwise direction of Figure 23 is generated by the force of the compression spring 12j when the developing sleeve 12d is assembled; therefore, the stopper projection 12i1 is located at the upper portion of the sleeve bearing 12i to counter this force.

<Frame Strength on Driving Member Side>

When the driving force is transmitted to the sleeve gear 12g, the sleeve gear 12g is subjected to a downward force (direction indicated by an arrow P in Figure 23(a)), whereby the bottom frame 15 is subjected to this force through the sleeve bearing 12i; therefore, there is a liability that the bottom frame 15 is deformed on the driving member side. To eliminate such a liability, the following structure is provided in this embodiment.

To begin with, the bottom frame 15 is molded in such a manner that the side wall for supporting the drum shaft 9d of the photosensitive drum 9 and the side wall for supporting the driven side of the developing sleeve 12d are connected as a single piece as shown in Figure 7, and the driving member portion of the bottom frame 15 forms a substantially box shape (right side portion in Figure 7), dispersing thereby the pressure imparted on the driving member portion of the bottom frame 15. Secondly, the strength of the frame portion molded in a substantially box shape has been increased by providing a large number of ribs 15p as shown in Figure 21 on the bottom surface (surface subjected to the aforementioned downward force). Thirdly, the influence of the aforementioned downward force exerted upon the bottom frame 15 through the sleeve bearing 12i is reduced by disposing the sleeve bearing 12i closer to the side wall of the bottom frame 15 than the sleeve bearing 12h on the other side.

By making the structural arrangement as described in the foregoing, the frame strength of the driving member portion of the bottom frame 15, in particular the portion corresponding to the driven side of the driving means 12, can be increased. In this embodiment, all three methods are employed, but it is needless to say that each method can be effective on its own.

<Connection of Sleeve Gear to Developing Sleeve>

Next, a method for connecting the sleeve gear 12g to the developing sleeve 12d will be described. Figure 25 is a schematic drawing for depicting how the developing sleeve 12d and sleeve gear 12g are connected. Referring to Figure 25(a), a sleeve flange 12k is fixedly fitted in one end (driven side) of the cylindrical developing sleeve 12d having an external diameter of 12 mm, by gluing, crimping, press-fitting, or the like. This sleeve flange 12k comprises three diameter-differentiated (stepped) portions: a portion 12k1 having an external diameter smaller than an internal

diameter of a gate portion 12d2 of the contact ring 12d1, a portion 12k2 having an external diameter smaller than an external diameter of the portion 12k1 and being rotatively supported by the sleeve bearing 12i, and a fitting portion 12k3 provided with peaks and valleys to be fitted into the sleeve gear 12g.

The length by which the diameter-differentiated portion 12k1 of the sleeve flange 12k projects is larger than the thickness of the gate portion 12d2 of the contact ring 12d1; therefore, even after the developing sleeve 12d moves in the thrust direction, the sleeve bearing 12i does not rub on the contact ring 12d1. The diameter of the engagement of the portion 12k2 at which the sleeve flange 12k is rotatively supported by the sleeve bearing 12i is approximately 6 mm - 8 mm.

The fitting portion 12k3 with peaks and valleys to be fitted into the sleeve gear 12g has an external diameter smaller by one step than the external diameter of the diameter-differentiated 12k2, and comprises two different portions: valley portions 12k5 with a smaller circumferential diameter of 4 mm - 5 mm, and peak portions 12k4 with a larger circumferential diameter than that of the valley portion 12k5, projecting thereby from the valley portion 12k5. The projection height of the peak portion 12k4 is approximately 0.7 mm and its width is approximately 2.0 mm, and the circumference D of the peak portion 12k4 and circumference d of the valley portion 12k5 are concentric. The sleeve flange 12k and sleeve gear 12 are adjustably fitted (H-js fitting), wherein the valley portion 12k5 of the fitting portion 12k3 is selected as the location for center-matching and tightening; therefore, there is a play at the location of the peak portion 12k4 of the fitting portion 12k3. Further, the sleeve gear 12g is provided with a fitting hole 12g2 to be engaged with the portion 12k3 of the sleeve flange 12k, and also, is provided with a boss portion 12g1, so that the length by which the portion 12k3 of the sleeve flange 12k is fitted into the sleeve gear 12g becomes larger than the gear tooth width. Therefore, the permissible driving force is increased.

As to the material for the sleeve flange 12k, aluminum alloy, or plastic material such as polyacetal (POM), polybutylene-terephthalate, (PBT), polyamide (PA), and the like can be used. As to the material for the sleeve gear 12g, plastic material such as polyacetal, (POM), polybutylene-terephthalate (PBT), polyamide (PA), fluorinated polycarbonate (PC), and the like can be used.

In this embodiment, two peak portions are provided on the portion 12k3 at which the sleeve flange 12k is fitted into the sleeve gear 12g, but the same effect can be obtained by providing three or four peak portions. In particular, when the sleeve gear 12g is manufactured of plastic by injection-molding, the thickness can be made more uniform by having four valleys; therefore, it becomes easier to improve the manufacturing accuracy. Further, the sleeve flange 12k is fitted into the sleeve gear 12g so as to make adjustable contact at the valley portion 12k5 of the fitting portion 12k3, but the adjustable contact may be made at the peak portion 12k4, providing the play at the valley portion 12k5.

(Cleaning Means)

<Structure of Cleaning Means>

The cleaning means 13 is for removing the residual toner after the toner image on the photosensitive drum 9 has been transferred onto the recording medium by the transferring means 6. Referring to Figure 3, this cleaning means 13 comprises a cleaning blade 13a for scraping off the residual toner on the photosensitive drum 9, a receptor sheet 13b for scooping away the scraped-off toner, being disposed below the cleaning blade 13a as well as being in contact with the surface of the photosensitive drum 9, and a waste toner storage 13c for storing the scooped-off waste toner.

<Receptor Sheet>

Here, how the receptor sheet 13b is attached will be described. This receptor sheet 13b is pasted on an attachment surface 13d provided on the waste toner storage 13c, with a double-side adhesive tape. However, the waste toner storage 13c is formed by the bottom frame 15 and top frame 14 which are made of resin material, and its attachment surface 13d is not perfectly flat. Therefore, when the double sided adhesive tape 13e is pasted on the attachment surface 13d and the receptor sheet 13b is simply pasted on this double sided adhesive tape 13e, the tip (where it makes contact with the photosensitive drum 9) of the receptor sheet 13b sometimes becomes wavy as indicated by a reference code U. With the presence of the wave U at the tip of the receptor sheet 13b, the receptor sheet 13b does not tightly contact the surface of the photosensitive drum 9, failing thereby to reliably scoop off the toner scraped off by the cleaning blade 13a.

Therefore, it is conceivable to give tension to the tip of the receptor sheet 13b in order to prevent the generation of the wave U. In other words, the appearance of the wave U can be prevented by pasting the receptor sheet 13b while the attachment surface 13d is elastically bent by pulling downward the attachment surface 13d located at the bottom portion of the wast toner storage, with a pulling tool 21, and stopping pulling after pasting the receptor sheet 13b, so that the tension can be given to the tip of the receptor sheet 13b as the attachment surface 13d straightens itself due to the material elasticity.

However, in the process cartridge B having been

being recently downsized, the size of the attachment surface 13d for the receptor sheet 13b also has become smaller. Therefore, when the receptor sheet 13b is pasted while the attachment surface 13d is bent, the receptor sheet 13b sticks out downward at both bottom ends 13b1, as shown in Figure 17(a). When the receptor sheet 13b sticks out downward below the attachment surface 13d, the recording medium is liable to hang up at the protruding receptor sheet 13b.

Further, when the receptor sheet 13b is pasted while the attachment surface 13d is bent, the double sided adhesive tape 13e sticks out downward from the bottom side of the receptor sheet 13b. Therefore, if, in this state, the receptor sheet 13b is pressed upon the double sided adhesive tape 13e by a pasting tool 22, the protruding portion of the tape 13e sticks to the pasting tool 22 as shown in Figure 27(b), and when the pasting tool 22 is removed, the double sided adhesive tape 13e is peeled off the attachment surface 13d, and subsequently, the receptor sheet 13b is improperly attached.

Therefore, in this embodiment, the bottom end shape of the receptor sheet 13b is made substantially the same as the shape into which the attachment surface 13d is bent as it is pulled by the pulling tool 21, as shown in Figure 28(a). In other words, the receptor sheet 13b is made wider along the longitudinal middle portion than at both longitudinal ends. With this design, the bent double sided adhesive tape 13e is prevented from sticking out from the receptor sheet 13b. Further, when the pulling by the pulling tool 21 is stopped to allow the attachment surface 13d to straighten, and to give thereby the tension to the upper end of the receptor sheet 13b, the bottom end of the receptor sheet 13b does not stick out from the bottom of the attachment surface 13d. Therefore, the improper attachment of the receptor sheet 13b or resultant recording medium hang-up at the receptor sheet 13b as described in the foregoing can be eliminated.

Further, when the simplification of the processing of the receptor sheet 13b, service lives of the processing tools, or the like, is taken into consideration, the bottom end shape of the receptor sheet 13b is preferred to be linear. Therefore, a linear configuration as shown in Figure 29 may be used for making the receptor sheet 13b wider toward the longitudinal center, following substantially the bottom end curvature of the receptor sheet 13d.

Also, in this embodiment, in order to bend the attachment surface 13d for the receptor sheet 13b, the attachment surface 13d is pulled by the pulling tool 21, but it is needless to say that the attachment surface 13d for the receptor sheet 13b may be bent by pressing, with a pressing tool 23, the upper portions of partitioner plates 13c1 provided within the waste toner 13c formed integrally with the attachment surface 13d for the receptor sheet 13b, as shown in Figure 30.

Also, in this embodiment, the receptor sheet attachment surface 13d is formed at the bottom portion of the waste toner storage 13c, but the same effect can be obtained by employing such a structure that the receptor sheet 13b is pasted on an attachment surface of a member made of material such as metallic plate, different from that for the waste toner storage 13c, and such a metallic plate member is assembled into the waste toner storage 13c.

<Cleaning Blade>

Referring to Figure 3, the cleaning blade 13a is made of elastic material such as polyurethane rubber (JISA hardness: 60 degrees to 75 degrees), and is integrally fixed to a supporting member 13a1 made of metallic plate such as cold-rolled steel plate. The supporting member 13a1 to which the cleaning blade 13a is affixed is attached, with screws or the like, to the cleaning blade mounting surface of the bottom frame 15 to which the photosensitive drum 9 is attached. The cleaning blade mounting surface of the bottom frame 15 is precisely formed so that when the supporting member 13a1 to which the cleaning blade 13a is affixed is mounted on it, the edge portion of the cleaning blade 13a is placed in contact with the photosensitive drum 9, with a predetermined precise contact pressure.

Since a primary charge bias, that is, a voltage generated by superposing an AC voltage on a DC voltage as described hereinbefore, is applied to the charging roller 10 of the process cartridge B, the photosensitive drum 9 is caused to oscillate microscopically by this AC component (approximately 2 KV_{p-p}). This microscopic oscillation of the photosensitive drum 9 is liable to trigger so-called stick slip of the cleaning blade 13a, which causes vibrations. The vibration of the cleaning blade 13a due to the stick-slip is large, and this large vibration is transmitted, through the supporting member 13a1 to which the supporting member 13a1 is affixed, to the bottom frame 15 and further, to the top frame 14, whereby noises are sometimes generated.

Therefore, in this embodiment, as a means for suppressing the noise caused by the vibration of the cleaning blade 13a, a rib 14j is provided at a predetermined location within the top frame 14 as shown in Figures 31 and 32, and this rib 14j is abutted on the upper surface of the supporting member 13a1 to which the cleaning blade 13a is affixed. Further, in order to prevent the waste toner from leaking out of the waste toner storage 13c, a seal member S1 made of foamed urethane or the like is pasted to the rib 14j, being compressed between the rib 14j and supporting member 13a1. As a result, the vibration of the cleaning blade 13a is suppressed by the cooperation between the resiliency of the S1 and rib 14j, prevent-

ing thereby the noises related to the aforementioned vibration. As is evident from the above description, the supporting member 13a1 of the cleaning blade 13a is sandwiched by the top frame 14 and bottom frame 15, with S1 being interposed. In other words, the process cartridge B is assembled in the following manner: the cleaning blade 13a is mounted on the bottom frame 15 by attaching the supporting member 13a1 to the bottom frame 15 with screws, and then, the top frame 14 and bottom frame 15 are put together as if compressing the supporting member 13a1 between the top frame 14 and bottom frame 15.

As for the rib 14j, its height is selected to leave "zero" clearance between the upper surface of the supporting member 13a1, on which the rib 14j is abutted, and internal surface of the top frame 14. Further, in this embodiment, the rib 14j is centered in the longitudinal direction of the cleaning blade 13a, and its length L_R is made to be approximately 180 mm or more. As a result, the top frame 14 is bent by the reaction from the cleaning blade 13a by approximately 0.5 mm - 1.0 mm, but this problem can be easily dealt with by designing this bending into the configuration of the top frame 14.

<Relation between Average Toner Diameter and Blade Contact Pressure>

In recent years, image quality has been desired to be higher and higher, and accordingly, the toner diameter has been progressively reduced to satisfy this desire. In the past, toner having an average particle diameter of approximately 9 μm had been used, but in this embodiment, toner having an average particle diameter of approximately 7 μm is used. The normal distribution curve in Figure 33 represents the toner particle size distribution of such toner. As is evident from Figure 33, the more the toner particle size is reduced, the more the amount of the smaller toner particles increases. Therefore, the contact pressure with which the cleaning blade 13a contacts the photosensitive drum 9 must be increased in proportion to the degree of fineness of the toner particle; otherwise, the toner slips by the cleaning blade 13a, being liable to cause so-called cleaning failure. Further, the toner which has slipped by the cleaning blade 13a is liable to remain stuck on the surface of the photosensitive drum 9, being compacted by the charging roller 10 and fused on the drum surface, or is liable to adhere to the charging roller 10, causing thereby the improper charging.

Therefore, in this embodiment, the contact pressure with which the cleaning blade 13a contacts the photosensitive drum 9 is increased as the toner particle size is reduced. Hereinafter, descriptions will be given as to a method for measuring the contact pressure of the cleaning blade 13a, and the results of an endurance test conducted by the applicant of this patent, in which the cleaning performance, charging characteristic, and photosensitive drum condition were studied by making 5,000 copies under normal conditions while changing the blade pressure and toner particle diameter.

First, referring to Figure 34, the amount of intrusion λ and setting angle ψ of the cleaning blade 13a in relation to the photosensitive drum 9 will be described. The amount of blade intrusion λ means an imaginary amount by which the tip of the cleaning blade 13a intrudes into the photosensitive drum 9 without deforming itself, and the approach angle ψ means the angle formed by the cleaning blade 13a and the tangential line of the photosensitive drum 9 at the contact point between the tip of the cleaning blade 13a and the photosensitive drum 9.

With the definition given in the foregoing, the method for measuring the contact pressure of the blade will be described referring to Figure 35. To begin with, a 1 cm wide piece is cut out of the cleaning blade 13a and is set on a blade mount 57 which is movable by a motor 56 in the direction indicated by an arrow, wherein this piece of cleaning means 13 is placed in contact with a load sensor 58, at a predetermined angle ψ selected within a range of approximately 20° - 25°. Then, the blade mount 57 is moved toward the load sensor by the amount equivalent to the desired amount of intrusion λ, and the value detected by the load sensor is amplified by an amplifier 59 to be read through a voltmeter 60. The voltage thus read is converted to the linear load per centimeter by the substitution with the linear load per unit voltage, prepared in advance. The value thus obtained is the blade contact pressure.

The applicant of the present patent conducted an endurance test, using the blade contact pressure measuring method described in the foregoing, in which the cleaning performance, charging characteristic, and photosensitive drum condition were studied by making 5,000 copies under normal conditions while varying the blade contact pressure and toner particle diameter. The results are given in Figure 36. During the test, in order to stabilize the charging characteristic, a superposed voltage of an approximately 1 KV DC and an approximately 2 KV AC voltage was applied to the charging roller. As for the developing system, it was a reversal development using single component magnetic toner. The reversal development referred in this test means a development process in which a latent image is developed by toner having the same charge polarity as that of the voltage of the latent image. In the case of this embodiment, a latent image having the negative polarity was formed on the surface of the image bearing member charged by the contact charging means having been charged to the negative polarity, and was developed by the toner having been charged to the same negative polarity. The process speed was approximately 20 mm/sec

- 160 mm/sec.

Referring to Figure 36, Test No. 1 represents a prior combination, in which a blade contact pressure was 15 gf/cm and toner having an average particle diameter of photosensitive drum 9 µm was used. As had been expected, the charging characteristic and photosensitive drum condition were good since the cleaning performance was sufficient.

In Test No. 2, the blade contact pressure was 15 gf/cm and toner having an average particle diameter of 7 µm was used. The cleaning failure began after approximately 1,000 copies had been made, and thereafter, the charge failure began after approximately 1,000 and several hundreds of copies had been made. In addition, the toner which slipped by the cleaning blade 13a was compacted and fused on the drum surface by the vibration generated by the superposed voltage applied to the charge roller 10.

In Test No. 3, the blade contact pressure was increased to 20 gf/cm and toner having an average particle diameter of 7 µm was used. The amount of the toner which slipped by the blade as described in the foregoing was reduced, but the cleaning performance was not sufficient. Therefore, the toner having slipped by the cleaning blade 13a was accumulated on the surface of the cleaning means 13, on the side in contact with the photosensitive drum 9, and after the 2,000th copy, the accumulated toner was carried off by the photosensitive drum 9 due to the deformation of blade tip, when the apparatus was started up. The carried-off toner adhered to the charging roller 10 and caused charge failure. However, the toner having adhered to the charging roller 10 was gradually removed while several copies were continuously made, and the charging performance was restored.

In Test No. 4, the blade contact pressure was kept at 20 gf/cm and toner having an average particle diameter of 4 µm was used. The results were substantially the same as those for Test No. 3.

In Test No. 5, the blade contact pressure was increased to 25 gf/cm and toner having an average particle diameter of 7 µm was used. The amount of slip-away toner was almost none, and therefore, almost no toner adhered to the cleaning means 13, on the side in contact with the photosensitive drum 9. Within the limit of this endurance test which made 5,000 copies, toner did not slip by the cleaning means 13 when the apparatus was started up, and the so-called cleaning failure did not occur. As a result, the cleaning performance, charge characteristic, as well as photosensitive drum condition, were good.

In Test Nos. 6 and 7, the blade contact pressure was kept at 25 gf/cm, and toner having an average particle diameter of 5 µm and toner having an average particle diameter of 4 µm were used, respectively. The results were the same as those for Test No. 5, wherein the cleaning performance, charge characteristic, as well as photosensitive drum condition, were good.

In Test Nos. 8 and 10, the upper limit of blade contact pressure was measured when toner having an average particle diameter of 7 µm was used. When the blade contact pressure was 60 gf/cm, there was no image related problem, but when the blade contact pressure was 65 gf/cm, the drum surface was substantially scarred, and after approximately 4,000th copies, streaks due to those scars appeared in the image.

In Test Nos. 9 and 11, the upper limit of blade contact pressure was measured when toner having an average particle diameter of 4 µm was used. The results were the same as those for Test Nos. 8 and 10, wherein there was no image related problem when the blade contact pressure was 60 gf/cm, but when the blade contact pressure was 65 gf/cm, the drum surface was substantially scarred, and after approximately 4,000th copies, streaks due to those scars appeared in the image.

According to the results given in the foregoing, with toner having an average particle diameter of 7 µm or less, the blade contact pressure must be set up to be at least 20 gf/cm or higher, and in order to produce always satisfactory images by preventing more reliably the cleaning failure, the blade contact pressure is preferred to be set within a range of 25 gf/cm - 60 gf/cm. Taking these upper and lower limits into consideration, it is more preferable to set the blade contact pressure at approximately 36 gf/cm. Therefore, in this embodiment, the elastic cleaning blade 13a was mounted on the bottom frame 15 in such a manner that when the average particle diameter is in a range of 4 µm - 7 µm, the cleaning blade 13a is placed in contact with the photosensitive drum 9, with a blade contact pressure in a range of 25 gf/cm - 60 gf/cm.

(Top and Bottom Frames)

The top and bottom frames 14 and 15 which make up the housing of the process cartridge will be described. Referring to Figure 6, on the bottom frame 15 side, the developing sleeve 12d constituting the developing means 12, developing blade 12e, and cleaning means 13 are disposed, in addition to the photosensitive drum 9. On the other hand, on the top frame 14 side, the charging roller 10, toner storage 12a constituting the developing means 12, and toner feeding mechanism 12b are disposed.

Referring to Figures 8 and 38, in order to combine the top and bottom frames 14 and 15, four pairs of claws 14 are integrally formed with the top frame 14, with approximately equal intervals. Referring to Figures 7 and 37, the bottom frame 15 is provided with holes 15a and 15b formed integrally with the frame 15, for engaging with the claws 14a. Therefore, the top and bottom frames 14 and 15 are connected as

the claws 14a are forcefully fitted into the engagement holes 15a and 15b, wherein the claw 14a and engagement holes 15a are elastically engaged and can be separated as needed. Further, in order to secure the connection, claws 15c and engagement holes 15d are provided toward both longitudinal ends of the bottom frame 15 as shown in Figures 7 and 37, and engagement holes 14b and 14c to engage with the engagement holes 15d and 15e are provided toward both longitudinal ends of the top frame 14 as shown in Figures 8 and 38. Referring again to Figures 7 and 37, positioning projections 15m are formed toward both longitudinal ends of the bottom frame 15, adjacent to where the photosensitive drum 9 is disposed. These projections 15m penetrate through holes 14g cut through the top frame 14 and stick out outward, as shown in Figure 4, when the top frame 14 is connected.

When various members constituting the process cartridge B are separately assembled into the top and bottom frames 14 and 15 as described in the foregoing, members such as the developing sleeve 12, developing blade 12e, cleaning blade 13a, and the like, which are needed to be specifically positioned relative to the photosensitive drum 9, are disposed on the same frame side (in this embodiment, bottom frame 15), whereby each member can be precisely positioned, while simplifying the assembly process of the process cartridge B.

Further, the bottom frame 15 of this embodiment is provided with engagement concavities 15n disposed adjacent to one of its edges as shown in Figures 7 and 37, and the top frame 14 is provided with engagement projections 14h disposed adjacent to one of its edges, to engage with the concavities 15n, at respective approximate midpoints of the intervals of the claws 14a.

In addition, the bottom frame 15 of this embodiment is provided with a pair of engagement concavities 15e, an engagement projection 15f1, and an engagement concavity 15f2, which are disposed adjacent to each of respective corners of the frame as shown in Figures 7 and 37, and the top frame 14 is provided with a pair of engagement projections 14d, an engagement concavity 14e1, and an engagement projection 14e2, which are disposed adjacent to each of respective corners of the frame 14 as shown in Figures 8 and 38, to engage with the pair of engagement concavities 15e, engagement projection 15f1, and engagement concavity 15f2. Adjacent to the engagement concavity 15f2, an engagement hole 15f3 is provided, and adjacent to the engagement projection 14e2, an engagement claw 14e3 to engage with the engagement hole 15f3 is provided.

Therefore, when the upper and bottom frames 14 and 15 are put together, the engagement projections 14h, 14d, 14e2, and 15f1 are engaged with the engagement concavities 15n, 15e, 15f2, and 14e1, respectively, and further, the engagement claw 14e3 is engaged with the engagement hole 15f3, whereby both top and bottom frames 14 and 15 are firmly combined so that the combined top and bottom frames 14 and 15 will not shift from each other even when a twisting force is exerted upon them.

The engagement projections, engagement concavities, engagement claws, and engagement holes may be disposed at different locations other than those described in the foregoing as long as they can be situated so as to afford the resistance to the twisting force exerted upon the upper and bottom frames 14 and 15.

Referring to Figure 6, the top frame 14 is provided with a shutter mechanism 24 which protects the photosensitive drum 9 from the external light, dust, or the like when the process cartridge B is out of the image forming apparatus A. The structural detail of this shutter mechanism 24 will be described later.

The bottom surface of the bottom frame 15 functions as a guide for conveying the recording medium. At this time, a more detailed description will be given as to the bottom surface of the bottom frame 15 which functions as the guide for conveying the recording medium.

Referring to Figure 39, a guide portion 15h of the bottom surface of the bottom frame 15, being on the upstream side of a nip N formed between the photosensitive drum 9 and the transferring roller 6, is situated to deflect the recording medium P by an amount La (La = 5.0 mm - 7.0 mm), in relation to the direction of a tangential line N1 at the position of the nip N. Since this guide portion 15h is a part of the bottom surface of the bottom frame 15 which is constructed so as to provide a space for the developing sleeve 12d and a space necessary for feeding the toner to the sleeve 12d, its configuration and position is affected by the position of the developing sleeve 13d or the like which is determined for obtaining a proper developing condition; therefore, when an attempt is made to align this surface closer to the direction of the tangential line N1, the bottom frame 15 becomes thinner, creating a problem regarding the strength of the process cartridge B.

Below the bottom surface of the bottom frame 15, the location of the lower end 13f of the cleaning means 13, which is disposed on the downstream side relative to the direction in which the recording medium is conveyed, is determined by how the cleaning blade 13a, receptor sheet 13b, or the like are arranged in the cleaning means 13, and also, is selected to be a location having a distance of Lb (Lb = 4.5 mm - 8.0 mm) (approximately 6.2 mm in this embodiment) from the tangential line N, so that the lower end 13f does not interfere with the recording medium P. Further, in this embodiment, an angle δ in Figure 39, which is the angle formed between the perpendicular from the rotational center of the photosensitive drum 9 and the

line connecting the rotational centers of the photosensitive drum 9 and transferring roller 6, is set so as to satisfy: δ = 10° - 30° (approximately 20° in this embodiment.

(Shutter Mechanism)

In order to transfer the toner image onto the recording medium, the photosensitive drum 9 is made to face the transferring roller 6 through the opening 15g (Figure 42) provided on the bottom frame 15. However, if the photosensitive drum 9 remains exposed when the process cartridge B is out of the image forming apparatus A, the photosensitive drum 9 is deteriorated by being exposed to the external light, and also, dust may adhere to the photosensitive drum 9. Therefore, the process cartridge B is provided with the shutter mechanism 24 for protecting the otherwise exposed portion of the photosensitive drum 9 from external light, dust, or the like when the process cartridge is out of the image forming apparatus A. Hereinafter, the structure of the shutter mechanism will be described in detail referring to Figures 40 - 44.

<Structure of Shutter Mechanism>

Referring to Figure 40, the shutter mechanism 24 comprises a shutter arm 24a, a shutter linkage 24b, a shutter portion 24c, shaft retainers 24d and 24e, and a torsion spring 24f; and automatically opens or closes as the process cartridge B is installed into, or taken out of, the image forming apparatus A.

The shutter arm 24a is made of metallic material, and is rotatively held, at two points toward the ends, by retaining portions 24d1 and 24e1 (Figure 43) of the shaft retainers 24d and 24e, as shown in Figure 40. By this shutter arm 24a, the shutter linkage 24b is rotatively supported, wherein the rotationally central portion 24b1 of the shutter linkage 24b is regulated by a rotation regulating portion 24a2 of the shutter arm 24a, preventing thereby the shutter linkage from rotating more than a given angle in the direction indicated by an arrow dl. By the shutter linkage 24b, the shutter portion 24c is rotatively supported, wherein the rotationally central portion 24c1 of the shutter portion 24c is regulated by a rotation regulating portion 24b2 of the shutter linkage 24b, preventing thereby the shutter portion 24b from rotating more than a given angle in the direction indicated by an arrow el.

The shaft retainer 24d holding rotatively one end of the shutter arm 24a is provided with a projection 24d2 (Figure 43) projecting from the retaining portion 24d1, and in this projection, the torsion spring 24f is fitted. One end of the torsion spring 24f is placed in a groove 24d3 of the shaft retainer 24d, and the other end is rested on a supporting portion 24a3 of the shutter arm 24a which supports rotatively the shutter linkage 24b; therefore, the shutter arm 24a is provided with a rotational moment in the direction indicated by an arrow f as shown in Figure 41. Being pressured by the force from the torsion spring 24f, the rotation regulating portion 24a2 of the shutter arm 24a regulates the shutter linkage 24b in the direction indicated by an arrow d2, and in turn, the rotation regulating portion 24b2 of the shutter linkage 24b regulates the shutter portion 24c in the direction indicated by an arrow e2, whereby the shutter mechanism 24 is completely shut, as shown in Figure 41.

In this embodiment, the internal surface (surface facing the surface of the photosensitive drum 9) of the shutter portion 24c is molded to be slippery so that even when the shutter portion 24c and the photosensitive drum 9 make contact with each other while the shutter mechanism 24 is completely shut, the shutter portion 24c is prevented from damaging the surface of the photosensitive drum 9. Further, as shown in Figure 42, a shutter supporting portion 14k is provided at each of the longitudinal ends of the drum opening 15g of the bottom frame 14. This shutter supporting portion 14k holds the shutter portion 24c so that the shutter portion 24c does not contact the surface of the photosensitive drum 9 when the shutter mechanism is completely shut.

Further, the shutter mechanism can be attached to, or removed from, the top frame 14. More specifically, the shaft retainers 24d and 24e which support the shaft portion 24a1 of the shutter arm 24a are provided with engagement claws 24d4 and 24e4, respectively, and the shutter mechanism 24 is attached to the top frame 14 by engaging these engagement claws 24d4 and 24e4 into engagement holes (not shown) provided on the top frame 14, at respective longitudinal ends of the upper surface on the development side.

<Engaging Amount of Engagement Claw of Shaft Retainer>

The shutter mechanism is structured so as to open or close as the process cartridge B is installed or removed, and the force exerted on the shaft retainers 24d and 24e which retain the shutter mechanism on the top frame 14 varies when the shutter mechanism 24 is opened or closed. Since only the shaft retainer 24d out of the pair of shaft retainers 24d and 24e is fitted with the torsion spring 24f which pressures the shutter mechanism in the shutting direction, the force exerted on the shaft retainer 24d is larger than that exerted on the other shaft retainer 24e which is not fitted with the torsion spring 24f; therefore, its deformation also is larger. As a result, when the engaging amount of the engagement claw 24d4 of the shaft retainer 24d is the same as that of the engagement claws 24e4 of the other shaft retainer 24e, the engagement claw 24d4 may disengage. Therefore, in this embodiment, the engaging amount

of the engagement claw 24d4 of the shaft retainer 24d is made larger than the engaging amount of the engagement claws 24e4 of the shaft retainer 24e, so that the shaft retainer 24d does not easily disengage. More specifically, the engaging amount of the engagement claw 24d4 on one side of the shaft retainer 24d is made larger than that on the other side. In other words, while the shaft retainers 24d and 24e are arranged in the longitudinal direction of the top frame 14, the torsion spring 24f is provided on only one end, that is, on the shaft retainer 24d, and in case of this shaft retainer 24d, the engaging amount of the engagement claw 24d4 on one side of the shaft retainer 24d is different from that on the other side, whereas in the case of the shaft retainer 24e where the torsion spring 24f is not provided, the engaging amount of the engagement claws 24e4 on one side is the same as that on the other side. Therefore, the amount of strength by which the shaft retainer 24d or 24e remain engaged with the top frame 14 is different between them.

Given below is an exemplary set of concrete values for the engaging amount of the engagement claws 24d4 and 24e4 in this embodiment. The choice is not limited to this example, and may be made as fit.

(1) Engaging amount of engagement claws 24d4 on one side of shaft retainer 24d (D1): approx. 1.0 mm
(2) Engaging amount of engagement claws 24d4 on the other side of shaft retainer 24d (D2): approx. 1.1 mm
(3) Arm length of engagement claw 24d of shaft retainer 24d (D3): approx. 2.8 mm
(4) Engaging amount of engagement claws 24e4 on one side of shaft retainer 24e (E1): approx. 1.0 mm
(5) Engaging amount of engagement claws 24e4 on the other side of shaft retainer 24e (E2): approx. 1.0 mm
(6) Arm length of engagement claw 24e4 of shaft retainer 24e (E3): approx. 2.8 mm

<Rotational Center of Shutter Mechanism>

In the shutter mechanism 24, the shaft portion 24a1 of the shutter arm 24a, which is the rotational axis of the shutter mechanism, extends in the longitudinal direction of the top frame 14, on the development side upper surface of the top frame 14; therefore, this shaft portion 24a1 is liable to be deformed or subjected to like damage by being pulled by a user's hand during the cartridge installation or in the like situations. Further, referring to Figure 42, in this embodiment, in order to increase the toner space in the toner storage 12a, a bulge 12f3 is provided on the cover member 12f. If the shaft portion 24a1 which is the rotational axis of the shutter mechanism is extended over and across the bulge 12f3, the rotational range of the shutter mechanism is increased. Therefore, in this embodiment, in order to prevent such an increase, the bulge 12f3 of the cover member 12f is provided with a groove 12f4 extending in its longitudinal direction, as shown in Figure 44, and the shaft portion 24a1 is extended through this groove 12f4, so that it does not stick out above the upper surface of the bulge 12f3 of the cover member 12f.

{Assembly of Process Cartridge}

Next, how the process cartridge having the structure described hereinbefore is assembled will be described in detail, referring to drawings.

(Assembly Involving bottom frame)

Referring to Figure 45, first, in the bottom frame 15, in order to prevent the toner leak, contoured seal members S4 made of foamed urethane or the like are pasted, with double sided adhesive tape, on a developing sleeve seal bering surface 15i, and a contoured seal member S5 made of the same material is pasted in the same manner on a seat portion 15j1 which is located on the outward side of a cleaning blade mounting surface 15j, relative to the longitudinal direction of the bottom frame 15. In this embodiment, however, a felt material is used for the seal member S4 to be pasted on the developing sleeve seal bearing surface 15i, and foamed urethane is used for the seal member S5 to be pasted on the seat portion 15j1 located adjacent to the cleaning blade mounting surface 15j. The seal members S4 and S5 for preventing the toner leak do not need to be contoured. Instead, liquid material which can solidify into elastomer may be poured into concave portions formed where the seal members are to be seated in the frame.

The developing sleeve 12d is installed in the bottom frame 15 in which the seal member S4 is pasted. As described in the foregoing, the toner leak from the ends of the developing sleeve 12d is prevented by the seal member S4, wherein as shown in Figure 46, because of the relation between the rotational direction of the developing sleeve 12d (arrow direction in the drawing) and magnetic poles of the roller magnet 12c disposed within this sleeve, the toner adheres to the developing sleeve 12d, at the end portions of the developing sleeve 12d, that is, near the seal member S4, in a manner as indicated by the solidus in Figure 46; therefore, the sealing performance of the seal member S4 is desirably highest at the bottom portion 15i1 shown in Figure 47. Therefore, the sleeve seal bearing surface 15i of this embodiment is molded in such a manner that a radial distance from the center of the developing sleeve 12d to the bottom portion 15i1 of the sleeve seal bearing surface 15i becomes smaller than a radius R2 of the other portion. In other words, the relation between two radiuses R1 and R2

is: R1 < R2. With this arrangement, when the developing sleeve 12d is mounted in the bottom frame 15 through the bearings 12h and 12i, the seal member S4 is compressed more along the bottom portions 15i1 than along the other portion, increasing the sealing pressure between the developing sleeve 12d and the bottom portion 15i1, that is, improving the sealing performance. The sleeve seal bearing surface 15i in this embodiment is so formed as to make the seal member S4 to be compressed approximately 0.4 mm more along the bottom portion 15i1 than along the other portion.

A blade supporting member 12e1 to which a developing blade 12e has been attached and the blade supporting member 13a1 to which the cleaning blade 13a has been attached are mounted, with screws 12e2 and 13a2, on corresponding blade mounting surface 15k and 15j of the bottom frame 15. At this time, in this embodiment, in order to allow the screws 12e2 and 13a2 to be inserted from the same direction as indicated by the broken lines in Figure 45, the blade mounting surfaces 15k and 15j for the blade supporting members 12e1 and 13a1, respectively, are formed substantially in parallel. Therefore, when the process cartridges B are mass-produced, the developing blade 12e and cleaning blade 13a can be automatically and consecutively screwed by an automated machine or the like. With this arrangement, a space for a screw driver or the like is provided, whereby the assembly efficiency for both blades 12e and 13a can be increased, and further, the opening directions of the molds for forming the housing (frame) can be made the same, whereby the mold structure can be simplified to reduce the manufacturing cost.

In this embodiment, the bottom frame 15 is molded so that the angles of the developing blade mount bearing surface 15k and cleaning blade mount bearing surface 15j, relative to the perpendicular drawn in Figure 45, become approximately 24° and 22°, respectively, both surfaces being substantially in parallel. Also, as described before, in order to screw consecutively both blades 12e and 13a with an automated machine or the like, the angles of both screw holes provided for screwing the developing blade 12e and cleaning blade 13a at the blade mounting surface 15k and 15j are made to be the same, that is, approximately 24° relative to the horizontal line drawn in Figure 45, so that they can be drilled by a single slide.

Instead of screwing, the developing blade 12e and cleaning blade 13a may be attached by gluing them on the bottom frame 15 with adhesives 12e4 and 13a3 as shown in Figure 48. Even in such a case, by making such an arrangement that both blades 12e and 13a can be glued from the same direction, the developing blade 12e and cleaning blade 13a can be consecutively attached with an automated machine or the like, as when the screws are used.

<Seal at Cleaning Blade Ends>

Further, a seal member S6 made of foamed polyurethane or the like is pasted to the bottom portion of the blade mounting surface 15j, as shown in Figure 49, wherein the bottom portion corresponds to the end portion of the cleaning blade 13a. The seal S6 is a seal for preventing the toner, scraped off by the cleaning blade 13a, from traveling sideways on the blade 13a and leaking out of the blade end.

When a distance LS (Figure 50) between the bottom edge of the seal member S6 and the contact area between the photosensitive drum 9 and seal member S6 is shortened (more specifically, less than 0. 5 mm) by the downsizing of the process cartridge B, the seal member S6 is liable to be dragged by the photosensitive drum 9 due to the torque of the photosensitive drum 9 and vibrations, and further, it is liable to be peeled off after a long period of use. In this embodiment, therefore, a high density polyethylene sheet 37 is pasted on the seal member S6, to reduce the friction between the photosensitive drum 9 and seal member S6, as shown in Figure 49.

Also, on the cleaning blade 13a, a solid lubricant such as polyvinylidene fluoride (PVDF), fluorinated carbon, silicon particles or the like is coated, so that the torque increase which occurs because of the tight contact due to lack of the toner on the photosensitive drum 9 during the start-up period is prevented, wherein in this embodiment, the lubricant 38 is also coated on seal member S6 as shown in Figure 51, whereby the friction between the drum end and seal member S6 is further reduced to prevent the dragging of the seal member S6.

<Seal at Developing Sleeve End>

Referring to Figure 52, in order to prevent the toner from leaking through a gap Lt created between the end portion of the developing blade 13 and the bottom frame 15 (end surface of the seal member S4 in Figure 52) and at the same time, to scrape off the toner layer on the gap Lt portion of the developing sleeve 12d, a seal member 7 is provided at each end of the developing blade 12e. This seal member 7 is, as shown in Figure 53, formed to accommodate the contour of the developing blade 12e being pressed on the developing sleeve 12d, so that the contact pressure with which the developing blade 12e is pressed upon the developing sleeve is not increased. By this arrangement, the seal member S7 prevents the toner leak, with its upper side portion S71, and scrapes off the toner on the end portion of the developing sleeve 12d, with the lower side portion S72.

As described before, the photosensitive drum 9 is attached after the blades 12e and 13a are attached. Therefore, in this embodiment, as shown in Figure 45, guide members 15q1 and 15q2 are provided in the

bottom frame 15, and the guide member 15q1 is disposed on the developing blade supporting member 12e1, on the surface facing the photosensitive drum 9, and the guide member 15q2 is disposed on the cleaning blade supporting member 13a1, on the surface facing the photosensitive drum 9. Both of them are located outside the image forming range of the photosensitive drum 9, relative to the longitudinal direction of the photosensitive drum 9 (range Ld in Figure 54). A distance Lg between the both guides 15q1 and 15q2 is set up to be larger than the external diameter Rd of the photosensitive drum 9.

Having such an arrangement, the photosensitive drum 9 can be attached last, with both end portions (portions outside the image forming range), relative to the longitudinal direction, being guided by the guide members 15q1 and 15q2, as shown in Figure 45. In other words, the photosensitive drum 9 is rolled down into the bottom frame 15, with the blade 13a being slightly flexed, and the developing sleeve being slightly pushed aside.

When, instead of following the steps described in the foregoing, other members such as the blades 12e and 13a are assembled after the photosensitive drum 9 is placed first, there is a chance of damaging the surface of the photosensitive drum 9 while the blade 12e or 13a or the like is attached. Also, tests such as measuring the attachment locations of the developing blade 12e and cleaning blade 13a or their contact pressures on the photosensitive drum 9 cannot be conducted, which is inconvenient. Further, the lubricant for preventing the torque increase or blade peeling caused by the tight contact between the blade 12e and the developing sleeve 12d or between the blade 13a and the photosensitive drum 9, which occurs due to lack of the toner during the start-up period, must be coated before the both blades 12e and 13a are attached to the bottom frame 15, which is liable to create such a problematic inconvenience that the lubricant untimely falls off during the assembly process. However, this problematic inconvenience can be eliminated by placing the photosensitive drum 9 last, as it is done in this embodiment.

As described in the foregoing, according to this embodiment, the tests such as positional checking can be conducted, with the developing means 12 and cleaning means 13 being attached to the frame, and further, the photosensitive drum 9 is prevented from being scarred or nicked on the image forming range during the photosensitive drum 9 installation. Further, the lubricant can be coated on the developing means 12 and cleaning means 13 after they are assembled into the frame; therefore, the lubricant is prevented from falling off, preventing effectively the torque increase caused by the tight contact between the developing blade 12e and developing sleeve 12d or between the cleaning blade 13a and photosensitive drum 9.

Also, in this embodiment, the drum guide members 15q1 and 15q2 are provided on the bottom frame 15, wherein they may be integrally formed with the bottom frame 15 or provided as separate members. Instead of such an arrangement, however, projections 12e5 and 13a4 may be provided on the blade supporting members 12e1 and 13a1, respectively, at both their ends, relative to their longitudinal direction, outside the image forming range of the photosensitive drum 9, as shown in Figure 55, to be used as the guides when the photosensitive drum 9 is installed in the bottom frame 15, wherein they may be integrally formed with the blade supporting members 12e1 and 13a1, respectively, or may be provided as separate members.

<Mounting of Photosensitive Drum Insertion>

In this embodiment, the photosensitive drum 9 is inserted in the direction which forms a predetermined angle γ relative to the contact surface of the cleaning blade 13a as shown in Figure 45. This is because there is an area Lc at the edge of the free end of the blade 13a, where several tens of microns wide surface is left uncoated with the lubricant as microscopically seen, as shown in Figure 56(a), even through it looks uniformly covered with the lubricant, including the edge, as macroscopically observed.

Therefore, the photosensitive drum 9 is installed in the aforementioned manner, whereby after the photosensitive drum 9 contacts the cleaning blade 13a, the lubricant 38 on the blade 13a is dragged as the photosensitive drum 9 invades, and is dispersed as far as the Lc which has not been coated with the lubricant 38. As a result, by the time the drum 9 is completely installed, the lubricant 38 is going to be present over the entire contact surface between the drum 9 and blade 13a.

As described in the foregoing, the drum 9 is installed in the direction which forms a predetermined angle γ relative to the contact surface of the blade 13. However, according to a test conducted by this inventor, it is evident, generally speaking, that when the rubber hardness of the blade 13a is 60° or more and at the same time the amount of invasion is 0.5 mm or more, or when the contact pressure between the blade 13a and the drum 9 is 15 gf/cm or more, the aforementioned effect can be obtained if the approach angle γ of the drum 9 is 45° or less relative to the contact surface of the blade 13a. In this embodiment, the drum 9 is installed holding an angle γ of approximately 22°.

<Installation of Drum Axle and Bearing Members>

After the developing sleeve 12d, developing blade 12e, and cleaning blade 13a have been assembled into the bottom frame 15 in a manner as descri-

bed hereinbefore, a drum axle 9d having a supporting member 9d4, and a bearing member 16 are attached to respective ends of the photosensitive drum 9, as depicted by the oblique drawing in Figure 57 and the sectional drawing in Figure 22, whereby the photosensitive drum 9 is rotatively mounted in the bottom frame 15. The bearing member 16 is made of a material such as polyacetal having slippery properties, and comprises a drum axle bearing portion 16a to be fitted into the photosensitive drum 9, sleeve bearing portions 16b, and D-cut bore portion 16c into which an axle end of a D-cut magnet 12c is fitted, wherein the three portions are integrally formed.

Therefore, the photosensitive drum 9 and magnet 12c are supported by bearings as the bearing portion 16a is fitted into the end of the cylindrical photosensitive drum 9; the end portion of the magnet is fitted into the D-cut bore portion 16c; and the axle bearing member 16 is fixedly fitted into the side wall of the bottom frame 15. Referring to Figure 57, an electrically conductive ground contact 18a is attached to the bearing member 16, and the ground contact 18a comes in contact with an electrically conductive (aluminum) base member 9a of the photosensitive drum 9 as the bearing member 16 is fitted into the photosensitive drum 9 (Figure 10). Further, the bearing member 16 is provided with a bias voltage contact 18b, which comes in contact with an electrically conductive member 18d as the bearing member 16 is attached to the developing sleeve 12d, wherein the bias voltage contact is in contact with the internal surface of the developing sleeve 12d.

Since the photosensitive drum 9 and magnet 12c are supported by a single-piece bearing member 16 as described in the foregoing, the positional accuracy is improved for both components 9 and 12, and further, the component count is reduced, whereby not only the assembly process can be simplified but also the manufacturing cost can be lowered.

Further, since the positions of the photosensitive drum 9 and magnet 12c are fixed with use of a single component, the photosensitive drum 9 and magnet 12c can be more precisely positioned; therefore, magnetic force can be uniformly exerted on the surface of the photosensitive drum 9, which in turn make it possible to create smooth, precise, and vivid images.

Further, by providing the bearing member 16 with the drum ground contact 18a for grounding the photosensitive drum 9, and the developing bias contact 18b for applying the bias to the developing sleeve 12d, the components are effectively downsized, and subsequently, the process cartridge B itself can be effectively downsized.

Further, the bearing member is provided with a portion to be supported for fixing the position of the process cartridge B within the apparatus main assembly when the process cartridge B is installed in the image forming apparatus; therefore, the process cartridge B can be accurately positioned in the apparatus main assembly.

Referring to Figure 22, the bearing member 16 is also provided with the drum axle 16d, that is, a cylindrical, outward projection. When the process cartridge B is installed in the apparatus main assembly A, this axle portion 16d and the axle hole portion 15s of the bottom frame 15, to which the drum axle 9d of the other end is fitted as will be described later, are rested in a U-shaped groove portions 2a1 of a cartridge accommodating portion 2, whereby the position of the cartridge B is fixed. Since the position of the process cartridge B is fixed by the axle hole portion 15s, which directly bears the photosensitive drum 9, and the axle portion 16d, the process cartridge B can be more precisely positioned without being affected by the processing accuracy for other components or the assembly tolerance.

Also referring to Figure 22, the other end of the magnet 12c is fitted in the concave portion of the sleeve flange 12k, wherein the external diameter of the magnet 12c is formed to be slightly smaller than the internal diameter of the concavity. Therefore, the magnet 12c is held so as to afford a play, on the sleeve flange 12k side, whereby the magnet is held by its bottom side because of the self weight, or slightly displaced toward the blade supporting member 12e1 by its own magnetic force, since the blade supporting member 12e1 is made of magnetic metallic plate such as zinc plated steel plate.

By allowing the presence of a play between the sleeve flange 12k and magnet 12c, the frictional torque between the magnet 12c and rotatively sliding sleeve flange 12k can be reduced, which in turn can reduce the torque of the process cartridge itself.

(Installation into Top frame)

On the other hand, in the top frame 14, the sliding bearing 10c is attached, as described before, first, to the bearing slide guide claw 14n through the spring 10a, and the charging roller 10 is rotatively attached to the sliding bearing 10c. Further, the toner feeding mechanism 12b is attached within the toner storage 12a; a cover film 26 having a tear tape 25, shown in Figure 58, is pasted to the opening 12a2, through which the toner is fed out of this toner storage 12a to the developing sleeve 12d, in order to close the opening 12a2; the cover member 12f is welded; the toner is filled in the toner storage 12a; and then, the toner storage 12a is sealed. Next, the shutter mechanism 24 is attached to the top frame 14, on the upper surface of the development side, so that the shutter can be freely opened or closed. As stated before, this shutter mechanism 24 is attached by placing its shaft portion 24a1 in the groove 12f4 of the cover member 12f, and then, holding down the longitudinal end portions of the shaft portion 24a1 with the shaft retainers

24d and 24e (Figure 44).

<Tear Tape>

The tear tape 25 (made of, for example, polyethylene-terephthalate or polyethylene) provided on the cover film 26 pasted over the opening 12a2 of the toner storage 12a extends, as shown in Figure 58, from one of the longitudinal ends of the opening 12a2 (right end in Figure 58) to the other end (left end in Figure 58), and there, it is folded back to stick out through the opening 14f, a gap formed at the rear end of the top frame 14. The opening 14f is located so that the tear tape 25 faces an operator when the process cartridge B is installed into the apparatus main assembly A; therefore, it comes into the visual field of the operation, being likely to be easily noticed (Figure 44). Further, its visibility may be improved by making the color of the tear tape 25 more conspicuous against the color of the frames 14 and 15, for example, by selecting while, yellow, or orange color if the frame color is black.

Further, in order to improve the operability for the operator, the pulling direction (direction of an arrow g2) of the tear tape is made to be substantially opposite to the direction (direction of an arrow gl) in which the process cartridge B is installed into the apparatus main assembly A. With this arrangement, the operator can install the process cartridge B into the apparatus main assembly A, without switching hands, by holding the process cartridge B, for example, with his left hand, and pulling out the tear tape 25 with his right hand, toward himself. Also, even after the operator has installed the process cartridge B into the image forming apparatus A, without remembering to pull out the tear tape, the operator can pull out the tear tape 25 without switching hands after taking out the process cartridge B from the image forming apparatus A.

When a fresh process cartridge B is used, it is installed into the image forming apparatus A after the tear tape 25 sticking out of the opening 14f has been pulled out to peel off the cover film 26 pasted over the opening 12a2 of the toner storage 12a, so that the toner within the toner storage 12a is allowed to move toward the developing sleeve 12d.

(Seal Member to Be Placed between Top and Bottom Frames)

Next, the seal member to be pasted at the joint between the top frame 14 and bottom frame 15 will be described. Referring to Figures 37 and 38, a seal member is pasted at the joint between the top frame 14 and bottom frame 15. On the top frame 14, seal members S1, S2, and S3 are pasted, and on the bottom frame 15, seal members S8 and S9 are pasted. The toner leak through the joint between the upper and bottom frames 14 and 15 is prevented by these seal members. In this embodiment, the one which prevents the toner from leaking through the upper and bottom frames 14 and 15, on the cleaning means side, is the seal member S1, and the ones which prevent the toner from leaking through the joint between the frames 14 and 15, on the developing means side, are the seal members S2, S3, S8, and S9.

<Grooves and Ribs Located at Joint between Top and Bottom Frames>

As described in the foregoing, the seal members are pasted at the joint surfaces between the top frame 14 and bottom frame 15 to prevent the toner from leaking out of the process cartridge, wherein, as shown in Figure 6, the seal bearing surface of the top frame 14, on which the seal members S1, S2, and S3 are pasted, is provided with a groove 14m, and the surface of the top frame 15 which corresponds to the seal members S1, S2, and S3 is provided with a triangular rib 15r. Therefore, when the upper and bottom frames 14 and 15 are put together, the seal members S1, S2, and S3 are compressed to form a wave pattern as shown in Figure 53, whereby the sealing performances of the seal members at the joint between the top and bottom frames 14 and 15 are improved. In this case, since the seal members are only locally compressed, the reactions from the seal members hardly increase; therefore, the force combining the top and bottom frames 14 and 15 is not reduced. As stated in the foregoing, when the top and bottom frames 14 and 15 are put together, with the seal members S1, S2, and S3 being interposed, during the assembly process of the process cartridge B, the top and bottom frames 14 and 15 are joined in such a manner that the seal members S1, S2, and S3 are locally compressed.

Further, when the pressure is exerted on the toner within the process cartridge because of external factors (for example, vibrations or impacts), the pressurized toner may invade into the joint between the top and bottom frames 14 and 15, where the seal members S1, S2, and S3 are interposed. However, the advance of the toner is obstructed by the presence of the triangular ribs 15r and the reaction from the seal members S1, S2, and S3 being locally compressed by the triangular ribs 15r; therefore, the toner does not leak out of the joint between the top and bottom frames 14 and 15.

In this embodiment, foamed urethane such as MOLTPLANE (trade name) is used as the material for the seal members S1, S2, and S3, but liquid material which solidifies into an elastomer may be injected into the aforementioned groove 14m, so that it forms itself into the seal member.

As for the configuration of the projection, its section does not need to be triangular as long as it is a shape capable of compressing locally the seal mem-

bers. Also, the groove provided on the seal member bearing surface does not need to be present. Just for the record, in this embodiment, the thickness of the seal member is approximately 3 mm, and the seal member is compressed to a thickness of approximately 1 mm, wherein the height of the projection is approximately 0.5 mm.

<Hardness of Seal Member>

Among the seal members S1, S2, and S3 pasted on the joint surfaces between the top and bottom frames 14 and 15, the seal members S2 and S3 placed on the developing means side are harder than the seal member S1 placed on the cleaning means side. This is because the process cartridge B is flexed more on the developing means side than on the cleaning means side, in the longitudinal direction. In this embodiment, sealing material equivalent to Mesh 60 (#60) is used for the seal member S1 on the cleaning means side, and sealing material equivalent to Mesh 120 (#120) is used for the seal members S2 and S3 on the developing means side. As for the thicknesses of the seal members S1, S2, and S3, those having a thickness of approximately 3 mm are used and the necessary sealing performance is obtained by compressing these seal members to a thickness of approximately 1 mm as the top and bottom frames 14 and 15 are combined. These values are the optimum ones when both the sealing performance and the force combining the top and bottom frames 14 and 15 are taken into consideration.

<Convex side contact of tear tape>

As described hereinbefore, the seal member S8 and S9 are pasted on the bottom frame 15, at both longitudinal ends, on the developing means side. Out of two seal members S8 and S9, the seal member S8, being located on the side from which the tear tape 25 is pulled out, is pasted on the bent surface 15t of the bottom frame 15, starting from within the cartridge, following precisely the contour of the bent surface across the joint between the top and bottom frames 14 and 15 (position indicated by a broken line in Figure 59) and covering a wide area. With such an arrangement, when the operator pulls out the tear tape from the process cartridge B, the tear tape 25 is pulled out of the cartridge B, between the top frame 4 and its the counterpart portion of the seal member S8 pasted wide on the bent surface 15t. Therefore, the tear tape 25 always makes contact with the sealing member S8 at its convex side, thus preventing the seal member S3 from being peeled off as well as reduce the force needed to pull it out.

In other words, the tear tape 25 comes in contact with the arced portion of the bent seal member S8 and does not contact the edge portion of the seal member S8; therefore, the tear tape 25 does not peel off the seal member S8 when pulled out. Further, since the direction in which the tear tape 25 is pulled is made different from the longitudinal direction of the surface on which the tear tape 25 is pasted, the tear tape 25 does not come in contact with the edge of the elastic seal member S8 when pulled out. As is evident from the above description, according to the present invention, the tear tape 25 for sealing the opening 12a2 can be removably attached over the opening 12a2, so that it does not contact the edge of the seal member S8 when pulled out.

The top and bottom frames 14 and 15, into which various components have been assembled as described hereinbefore, are combined by engaging the engagement claws and engagement holes, and the like pairs, to complete the assembly process of the process cartridge B. Here, referring to Figure 60(a), description is given as to a shipment line. After various components have been assembled into the bottom frame 15, the assembled bottom frame 15 is inspected (for example, positional relation between the photosensitive drum 9 and developing sleeve 12d).

Then, this bottom frame 15 is put together with the top frame 14 into which the charging roller 10 and the like have been assembled, finishing thereby the process cartridge B, and this finished cartridge B is shipped out after being subjected to a general inspection. It is a simple line.

{Structure for Installing Process Cartridge}

How the process cartridge B is installed into the image forming apparatus A will be described, referring to drawings.

(Process Cartridge Installation Guide)

When the process cartridge B is installed into the image forming apparatus A, a top lid 1b is rotatively opened about an axis 1b4 positioned at the top portion of the apparatus main assembly 1, and the process cartridge B is inserted into the cartridge installation space 2 provided within the apparatus main assembly 1, from the direction indicated by an arrow in Figure 61. At this time, the process cartridge B is installed, being guided as shown in Figure 62, wherein the axle hole portion 15s and axle portion 16d of the bearing member 16, which project from respective longitudinal side surfaces of the process cartridge B, and a first engaging portion 14q, which extends from the axle hole portion 15s and axle portion 16d, diagonally upward toward the tail end (right side in Figure 62), relative to the cartridge installing direction, are guided by a first guide portion 2a provided on both inward surfaces of the installation space 2, and wherein a second engaging portions 15u and 14r provided on both longitudinal side surfaces of the process car-

tridge B, at the bottom-forward portion relative to the installing direction, are guided by a second guide portion 2b provided on both inward surfaces of the installation space 2.

The second engaging portion 15u, which is a projection, is disposed on the same side as the flange gear 9c provided on the photosensitive drum 9. Also, the second engaging portion 15u projects by approximately 2.7 mm from the cleaning means 13 side of the bottom frame 15, in the direction perpendicular to the axis of the photosensitive drum 9 (forward direction relative to the process cartridge B installing direction), wherein the cleaning means 13 is disposed in parallel to the axis of the photosensitive drum 9. Moreover, the engaging portion 15u is plate-shaped, having a tapered portion 15u1 toward the bottom (Figures 4 and 5). Further, the engaging portion 15u projects further downward by approximately 6 mm from the bottom surface of the cleaning means side of the bottom frame 15.

When, during the installation of the process cartridge B, an attempt is made to push the process cartridge B down and forward into the image forming apparatus A, in such a manner as for the process cartridge B to pivot about the axle hole portion 15s and axle portion 16d (counterclockwise direction), the process cartridge B does not go down because the second engaging portions 15u and 14r is in contact with the second guide portion 2b. On the contrary, when another attempt is made to push the process cartridge B down and rearward in a manner so as for the process cartridge B to pivot about the axle hole portion 15s and axle portion 16d, the process cartridge B does not go down any further because the first engaging portion 14q is in contact with the guide portion 2a.

Further, referring to Figure 63, while the process cartridge B passes over the transferring roller 6, the second engaging portion 15u keeps the axle portion 6d attached to one end of the transferring roller 6, pressed down; therefore, the bottom-forward portion of the process cartridge B, relative to the installing direction, does not contact the transferring roller 6 or the like, eliminating concern about damaging these components. At this time, the second engaging portion 14r located at the other end is in contact with the guide member 3b. Then, as the process cartridge B is inserted further into the apparatus main assembly, the second engaging portion 15u becomes disengaged from the axle portion 6d of the transferring roller 6, whereby the transferring roller 6 is pushed upward by a spring 6b to be pressed upon the photosensitive drum 9.

Therefore, the process cartridge B is smoothly inserted as it is guided by the guide portions 2a and 2b, and as the top lid 1b is closed as shown in Figure 1, the axle hole portion 15s and axle portion 16d are fitted into the approximately U-shaped groove portion 2a1 provided at the most downstream side of the first guide portion 2a, relative to the inserting direction, whereby the position of the process cartridge B is fixed.

(Shutter Mechanism Action during Cartridge Installation)

The process cartridge B is provided with a shutter mechanism 24 for protecting the surface of the photosensitive drum 9, wherein the shutter mechanism 24 in this embodiment is constructed to open automatically as the process cartridge B is installed into the image forming apparatus A. Hereinafter, the movement of the shutter mechanism 24 during the cartridge installation will be described.

As described hereinbefore, as the process cartridge B is inserted into the image forming apparatus A, the projecting portion 24a4 (Figure 40) provided adjacent to the supporting portion 24a3 of the shutter arm 24a comes in contact with a shutter cam surface 2c located on the top surface of the apparatus main assembly, at a position illustrated in Figure 62. As the process cartridge B is further inserted, the projection portion 24a4 of the shutter arm 24a moves to the right on the shutter cam surface 2c, whereby the shutter linkage 24b and shutter portion 24c also move to the right to be separated from the bottom portion of the bottom frame 15, exposing thereby the surface of the photosensitive drum 9 as shown in Figure 64. At this time, having been freed from the rotational regulation imparted by the rotation regulating portion 24a2 of the shutter arm 24a, the shutter linkage 24b is hanging from the supporting portion 24a3 of the shutter arm 24a, by its own weight, and resting in contact with the internal surface of the apparatus main assembly, but the shutter portion 24c is located where it is yet to be relieved from the rotational regulation by the rotation regulating portion 24b2 of the shutter linkage 24b.

As the process cartridge B is further inserted, the projecting portion 24a4 of the shutter arm 24a keeps moving in the right direction on the shutter cam surface 2c to the dead end, and then begins to move in the left direction, whereby the shutter linkage 24b hanging from the supporting portion 24a3 of the shutter arm 24b by its own weight is caused to begin rotating in the counterclockwise direction about the point at which it contacts the internal surface of image forming apparatus A. As the shutter linkage 24b is rotated enough to become perpendicular, in loose terms, the shutter portion which has been rotating together with the shutter linkage 24b comes in contact with the internal surface of the apparatus main assembly, whereby it is freed from the rotational regulation by the rotation regulating portion 24b2 of the shutter linkage 24b. With the top lid 1b of the apparatus main assembly being closed after the installa-

tion of the process cartridge B, the shutter mechanism 24 looks as shown in Figure 1, and the photosensitive drum 9 is in contact with the transferring roller 6.

As described in the foregoing, the shutter mechanism 24 in this embodiment not only automatically opens during the installation of the process cartridge B, but also, its shape and movement changes according to the contour of the internal surface of the apparatus main assembly. Further, it can be moved away from the drum while conserving space, contributing thereby to the overall downsizing of the image forming apparatus.

(Relation between Electrical Contact and Contact Pin)

The process cartridge B is provided with the electrically conductive drum ground contact 18a being in contact with the photosensitive drum 9, electrically conductive development bias contact 18b being in contact with the developing sleeve 12d, electrically conductive charge bias contact 18c being in contact with the charging roller 10, which are disposed to be exposed at the bottom surface of the bottom frame 15. As the process cartridge B is installed in the apparatus main assembly A in such a manner as described hereinbefore, the contacts 18a, 18b, and 18c are pressed on the drum ground pin 27a, development bias pin 27b, and charge bias pin 27c, respectively, which are located on the apparatus main assembly side as shown in Figure 65.

As for the structures of the contact pins 27a, 27b, and 27c, referring to Figure 65, they are fitted within a holder cover 28 in such a manner that they can project but cannot come out all the way, and also, are electrically connected, with electrically conductive compression springs 30, to the wiring pattern of a circuit board 28 to which the holder cover 28 is mounted.

Referring to Figure 66, the positioning of the electrical contacts in the process cartridge B will be described. Figure 66 is a plan view depicting schematically the positional relation between the photosensitive drum 9 and each of the electrical contacts 18a, 18b, and 18c.

As shown in Figure 66, the contact 18a, 18b, and 18c are located on the side opposite (non-driven side) to the one (driven side) where the flange gear 9c is attached, wherein the charge bias contact 18c is located on the downstream side of the photosensitive drum 9, relative to the recording medium conveying direction (cleaning means side), and the drum ground contact 18a and development bias contact 18b are located on the upstream side of the process cartridge B, relative to the recording medium conveying direction (developing means side).

Further, the contact points between the contacts 18a, 18b, and 18c and the contact pins 27a, 27b, and 27c on the apparatus main assembly side are arranged not to align in the direction (direction indicated by an arrow in the drawing) in which the process cartridge B is inserted (y3 and y4 in Figure 66). In other words, these contacts enter the apparatus main assembly in the consecutive order of the charge bias contact 18c, drum ground contact 18a, and development bias 18b, wherein the charge bias contact 18c is positioned where it does not interfere with the drum ground contact pin 27a and development bias pin 27b located within the apparatus main assembly, and the drum ground contact 18a is positioned where it does not interfere with the development bias contact pin 27b located within the apparatus main assembly. This arrangement is made to prevent the contacts which enter deeper into the apparatus from coming in contact with the contact pins located closer to the entrance side of the apparatus from being thereby damaged or broken, and from causing contact failure.

As described in the foregoing, by arranging the contact points not to align in the direction in which the process cartridge B is inserted, an optimum condition can be set up to avoid the interferences which otherwise may occur between the contacts on the apparatus main assembly side and the contacts on the process cartridge B side during the installation or removal of the process cartridge B. Therefore, it becomes easier to downsize the apparatus main assembly and process cartridge.

Further, among the contacts, the drum ground contact 18a and development bias contact 18b are positioned on the developing means side, relative to the photosensitive drum 9, and the charge bias contact 18c is positioned on the cleaning means side; therefore, the shape of the electrode within the process cartridge B can be simplified, which allows the process cartridge B to be downsized.

More specifically, the development bias contact 18b is located further away from the photosensitive drum 9 than the drum ground contact 18a, and the exposed surface area of the drum ground contact 18a is larger than that of the development bias contact 18b. Further, the configuration of the exposed surface of the development bias contact 18b is such a shape that a semispherical portion projects from a part of a rectangular parallelepiped, and the configuration of the exposed surface of the drum ground contact 18a is a boot shape. The exposed portion of the drum ground contact 18a is extended outward towards the photosensitive drum 9 from where it faces the photosensitive drum 9, and the exposed portion of the charge bias contact 18c is bent. The development bias contact 18b and drum ground contact 18a are located within the range in which the photosensitive drum 9 is coated with the photosensitive material (designated by Z in Figure 66).

Further, by placing the electrical contact points of the process cartridge B within the process cartridge

B rather than outside, adhesion of foreign matter to the contact, and resultant rust or deformation of the contact due to external force can be prevented.

Given below is an exemplary set of sizes for the electrical contacts according to this embodiment. The present invention, however, is not limited by this example and different sizes may be selected as fit.

(1) Distance between the photosensitive drum 9 and drum ground contact 18a in the direction perpendicular to the drum axis (X1): approx. 3.9 mm

(2) Distance between the photosensitive drum 9 and charge bias contact 18c in the direction perpendicular to the drum axis (X2): approx. 15.5 mm

(3) Distance between the photosensitive drum 9 and development bias contact 18b in the direction perpendicular to the drum axis (X3): approx. 23.5 mm

(4) Distance between the photosensitive drum 9 and drum ground contact 18a in the direction of the drum axis (Y1): approx. 11.5 mm

(5) Distance between the photosensitive drum 9 and charge bias contact 18c in the direction of the drum axis (Y2): approx. 1.5 mm

(6) Distance between the photosensitive drum 9 and development bias contact 18b in the direction of the drum axis (Y3): approx. 3.1 mm

(7) Distance between the lateral end of the drum ground contact 18a and the center of the contact (x1): approx. 10.3 mm

(8) Vertical length of the drum ground contact 18a (y1): approx. 6.0 mm

(9) Horizontal length of the charge bias contact 18c (x2): approx. 12.4 mm

(10) Vertical length of the charge bias contact 18c (y2): approx. 6.5 mm

(11) Horizontal length of the development bias contact 18b (x3): approx. 7.0 mm

(12) Distance between the vertical end of the development bias contact 18b and the center of the contact (y3): approx. 6.1 mm

(13) External radius of the drum ground contact 18a (r1): approx. 3.0 mm

(14) External radium of the development bias contact 18b (r2): approx. 3.0 mm

(15) Deviation between the contact point of the development bias contact 18b and the contact point of the drum ground contact 18a (y3): approx. 5.0 mm

(16) Deviation between the contact point of the development bias contact 18b and the contact point of the charge bias contact 18c (y4): approx. 7.5 mm

{Structure for Retaining Process Cartridge}

When the process cartridge B is inserted along the guide portions 2a and 2b following the procedure described hereinbefore, and the top lid 1b is closed, the process cartridge B must be positionally stabilized where it is. Therefore, in this embodiment, when the top lid 1b is closed, the process cartridge B is pressed on the internal surface of the cartridge installation space 2.

Referring to Figure 65, the top lid 1b is provided with a pressure generating means 1b1 having shock absorbing springs, at a predetermined location on the inward surface, and a plate spring 1b2, adjacent to its rotational center, wherein when the top lid 1b is open, the plate spring 1b2 is not in contact with the process cartridge B being installed.

With such a structure in place, when the top lid 1b is closed after the top lid 1b has been opened and the process cartridge B has been inserted up to the predetermined point along the guide portions 2a and 2b, the pressure generating means 1b1 provided on the internal surface of the top lid 1b presses down the top surface of the process cartridge B, and at the same time, an arm portion 1b3 of the top lid presses down the plate spring 1b2, which in turn presses down the top surface of the process cartridge B.

As a result, the axle hole portion 15s and axle portion 16 of the process cartridge B are pressed in the groove portion 2a1, whereby the position of the process cartridge B is fixed, and at the same time, leg portions 15v1 and 15v2 come in contact with abutment portions 2b1 and 2b2, being positionally fixed. As a result, the rotation of the cartridge B is regulated.

The leg portions 15v1 and 15v2 of the bottom frame 15 of the process cartridge B are provided at two locations, one on the driven side and the other on the non-driven side, on the bottom-portion, relative to the cartridge inserting direction (Figure 5), and the abutment portions 2b1 and 2b2 are provided on the second guide portions 2b, at predetermined locations corresponding to respective leg portions 15v1 and 15v2, wherein the two abutment portions 2b1 and 2b2 are of the same height, whereas the two leg portions 15v1 and 15v2 are made to be slightly different in height. More specifically, the leg portion 15v1 on the driven side is made to be taller by approximately 0.1 mm - 0.5 mm than the leg portion 15v2 on the non-driven side; therefore, the leg portion 15v1 on the driven side is always in contact with the abutment portion 2b1, whereas the leg portion 15v2 on the non-driven side remains in a state of being slightly lifted from the abutment portion 12b2. Therefore, under normal conditions, the position of the process cartridge B in the apparatus main assembly is fixed at three locations, that is, the locations at the axle hole portion 15s of the process cartridge B, axle portion 16d, and leg portion 15v1 on the driven side, whereby the attitude change of the process cartridge B is prevented even when the entire body of the process cartridge B is subjected to rotational moment in the

clockwise direction during the apparatus operation. As for the leg portion 15v2 on the non-driven side, only when the process cartridge B is deformed by an external force, for example, vibrations or the like, does it come in contact with the abutment portion 12b2 and function as a stopper.

(Force Exerted on Process Cartridge)

When the top lid 1b is closed after the installation of the process cartridge B, an upward force is also exerted on the cartridge B in addition to the downward pressure imparted by the pressure generating means 1b1 or the like, as described hereinbefore. Therefore, in order to stabilize the installed process cartridge B, the downward pressure exerted on the process cartridge B must be set up to be larger than the upward pressure.

<Upward Force>

The upward force exerted on the process cartridge B is generated by the electrical contact pins 27a, 27b, and 27c, transferring roller 6, and shutter mechanism 24.

During the installation of the process cartridge B, the electrical contact pins 27a, 27b, and 27c come to press down on the electrical contacts 18a, 18b, and 18c being exposed at the bottom surface of the cartridge B, and the transferring roller 6 comes to press on the photosensitive drum 9. Therefore, the process cartridge B is pressured upward by the forces Fc1, Fc2, and Fc3 from the springs 30 of the respective contact pins as shown in Figures 65 and 67, as well as by the force Ft from the spring 6b of the transferring roller 6 (Figure 1). Further, the shutter mechanism 24 opened by the installation of the process cartridge B remains pressured constantly in the closing direction by the torsional coil spring 24f. This force Fd is exerted on the process cartridge B in the same direction as that in which the process cartridge B is pulled when it is taken out, whereby the process cartridge B is pressured upward by the vertical components Fd1 and Fd2 of the force Fd.

<Downward Force>

On the other hand, the process cartridge B is pressured downward by the forces Fs1 and Fs2 from the pressure generating means 1b1, and the force Fs from the plate spring 1b2, as described previously. In addition, it is also pressured downward by the self weights Fk1, Fk2, and Fk3, and the rotation of the gear for transmitting the driving force to the photosensitive drum 9.

More specifically, referring to Figure 65, when the process cartridge B is installed, the flange gear 9c attached to one of the longitudinal ends of the photosensitive drum 9 engages with a driving gear 31 provided in the apparatus main assembly A, for transmitting the driving force of the driving motor. At this time, the direction of the operating pressure angle between the both gears 9c and 31 is set downward by an angle $\theta = 1° - 6°$ (approximately 4° in this embodiment), relative to the horizontal line. Therefore, during the image forming operation, a component Fg1 of the operating pressure Fg between the driving gear 31 and flange gear 9c works to pressure the process cartridge B downward. By directing the operating pressure Fg of the gears downward, relative to the horizontal line, the process cartridge B is prevented from being pushed up.

Further, having the operating pressure angle being directed downward relative to the horizontal line, even when the operator closes the top lid 1b without inserting the process cartridge B all the way (but enough to allow the top lid 1b to be closed), the process cartridge B is pulled in by the rotational force of the driving gear 31 as the driving motor rotates after the closing of the top lid 1b is detected, and the axle hole portion 15 and axle portion 16d engage into the groove portions 2a1, whereby the process cartridge B is properly installed.

When the process cartridge B is inserted so improperly that the flange gear 9c and driving gear fail to engage, the process cartridge B sticks out upward from the apparatus main assembly A and prevents the top lid 1b from being closed. Therefore, the operator will notice that the process cartridge B has been improperly inserted.

Further, even when the process cartridge B is subjected to a force directed in the diagonally left-downward direction in Figure 65 during the image forming operation, the axle hole portion 15s and axle portion 16d are abutted in the grooves 2a1 because of the aforementioned operating pressure angle; therefore, the process cartridge B remains stable. However, when the operating pressure angle is set diagonally left-downward in relation to the horizontal line as described in the foregoing, the positional arrangement becomes such that the flange gear 9c has to ride over the driving gear 31. Therefore, when the downward operating pressure angle is increased, the flange gear 9c is liable to collide with the driving gear 31 during the installation of the process cartridge B. In addition, the process cartridge B must be lifted higher before it can be pulled, during removal; otherwise, both gears 9c and 31 are liable to collide with each other, hampering thereby their disengagement. Therefore, the aforementioned diagonally left-downward operating pressure angle θ is preferred to be in a range of approximately 1° - 6°.

(Relation between Upward and Downward Forces)

As for the upward and downward forces exerted

on the process cartridge B as described in the foregoing, they have to satisfy the following conditions in order for the process cartridge B to be properly installed and for each of the contact pins to come and remain reliably in contact with the counterparts of the process cartridge B.

(1) An overall pressure exerted on the process cartridge B manifests as a downward pressure.

(2) The leg portion 15v1 on the driven side is not allowed to be pivoted about an axis connecting the axle hole portion 15s and axle portion 16 and lifted up.

(3) The axle hole portion 15s and axle portion 16d are not allowed to be pivoted about an axis connecting both leg portions 15v1 and 15v2, and to be thereby lifted up.

(4) The axle hole portion 15s on the driven side and leg portion 15v1 on the driven side are not allowed to be pivoted about an axis connecting the axle portion 16d on the non-driven side and leg portion 15v2 on the non-driven side, and to be thereby lifted up.

(5) The axle portion 16d on the non-driven side and the leg portion 15v2 on the non-drive side are not allowed to be pivoted about an axis connecting the axle hole portion 15s on the driven side and the leg portion 15v1 on the driven side, and to be thereby lifted up.

(6) The axle hole portion 15s on the driven side is not allowed to be pivoted about an axis connecting the axle portion 16d on the non-driven side and leg portion 15v1 on the driven side and lifted up.

(7) The axle portion 16d on the non-driven side is not allowed to be pivoted about an axis connecting the axle hole portion 15s on the driven side and leg portion 15v2 on the non-driven side, and to be thereby lifted up.

However, in the case of this embodiment, since the leg portion 15v2 on the non-driven side is slightly lifted above the abutment portion 2b2 anyway, Condition (7) may be eliminated; therefore, it only necessary to satisfy Conditions (1) - (6).

More specifically, in order to meet Condition (1), for example, only the following relation has to be satisfied:

$$Fs1 + Fs2 + Fs3 + FG1 + Fk1 + Fk2 + Fk3 > Fc1 + Fc2 + Fc3 + Ft + Fd1 + Fd2$$

Further, referring to Figure 68, in order to meet Condition (3), it suffices if necessary that a rotational moment about a point p of the leg portion 15v1 on the driven side satisfies the following mathematical expression, wherein M(T) in the expression is a reaction force generated by the cartridge torque, that is, a clockwise moment of the process cartridge B about the point p in the drawing.

$$M(Fs1 + Fs2) + M(Fs3) + M(FG1) + M(k1 + Fk2) > M(Fc1) + M(Fc2) + M(Fc3) + M(Ft) + M(Fd1 + Fd2) + M(T)$$

where M( ) is a moment.

Similarly, expressions which satisfy Conditions (1) - (6) are obtained, and the pressures Fs1, Fs2, and Fs3 are determined so as to satisfy all the conditions. As a result, the process cartridge B remains stabilized at a predetermined location within the apparatus main assembly during the image forming operation.

{Image Forming Operation}

Next, referring to Figure 1, a description will be given as to the image forming operation of the apparatus main assembly A in which the process cartridge B has been installed as described hereinbefore.

As the apparatus receives a recording start signal, a pickup roller 5a as well as a conveying roller 5b are driven, whereby the recording medium is separated and fed one by one out of the cassette 4 by a separating claw 4e, is reversed as it is guided along the guide 5c by the conveying roller 5b, and is delivered to the image forming station.

When the leading end of the recording medium is detected by an unshown sensor, an image is formed in the image forming station in synchronism with the conveying timing with which the leading end of the recording medium travels from the sensor to the transfer nip portion.

More specifically, the photosensitive drum 9 is rotated in the direction indicated by an arrow in Figure 1 in a manner so as to synchronize with the recording medium conveying timing, and in response to this rotation, a charge bias is applied to the charging means 10, whereby the surface of the photosensitive drum 9 is uniformly charged. Then, a laser beam modulated by the imaging signal is projected from the optical system 3 onto the surface of the photosensitive drum 9, whereby a latent image is formed on the drum surface in response to the projected laser beam.

At the same time as when the latent image is formed, the developing means 12 of the process cartridge B is driven, whereby the toner feeding mechanism 12b is driven for feeding out the toner within the toner storage 12g toward the developing sleeve 12d, and the toner layer is formed on the rotating developing sleeve 12d. The latent image on the photosensitive drum 9 is developed by the toner by applying to the developing sleeve 12d a voltage having the same polarity and substantially the same amount of electric potential as those of the photosensitive drum 9. Then, the toner image on the photosensitive drum 9 is transferred onto the recording medium having been delivered to the transfer nip portion, by applying to the transferring roller 6 a voltage having the polarity opposite to that of the toner.

While the photosensitive drum 9 from which the toner image has been transferred onto the recording medium is further rotated in the arrow direction in Fig-

ure 1, the residual toner on the photosensitive drum 9 is scraped off by the cleaning blade 13a. The scraped toner is collected in the waste toner storage 13c.

On the other hand, the recording medium on which the toner image has been transferred is guided by the cover guide 5e, being guided by the bottom surface, and is conveyed to the fixing means 7. In this fixing means 7, the toner image on the recording image is fixed by the application of heat and pressure. Next, the recording medium is reversed by the discharge relay roller 5f and the sheet path 5g, being thereby de-curled as it is reversely curved, and is discharged by the discharge roller 5h and 5i into the discharge tray 8.

{Procedure for Removing Process Cartridge}

When it is sensed by an unshown sensor or the like that the amount of toner in the developing means has become small during the image forming operation, this information is displayed on a display portion or the like of the apparatus main assembly A, whereby the operator is urged to replace the process cartridge B. Hereinafter, a process cartridge removal procedure for replacing the process cartridge B will be described.

When the process cartridge B is taken out of the apparatus main assembly A, the top lid 1b is opened as shown in Figure 69, to begin with. At this time, the pressure generating means 1b1 and plate spring 1b2 become separated from the process cartridge B, together with the top lid 1b, whereby the force Fs1 + Fs2 + Fs3 generated by the pressure generating means 1b1 and plate spring 1b2 is canceled. As a result, only the force Fk1 + Fk2 generated by the weight of the process cartridge B itself remains as the downward force exerted upon the process cartridge B.

At this point in time, since it had been arranged so that the upward force Fc1 + Fc2 + Fc3 exerted on the process cartridge B by the contact pins 27a, 27b, and 27c, the upward force Ft generated by the transferring roller 6, and the upward force Fd coming from the shutter mechanism 24 are slightly larger than the downward pressure Fk1 + Fk2 coming from the self weight of the process cartridge B, the process cartridge B is slightly lifted as the top lid 1b is opened, whereby the engagement between the flange gear 9c and driving gear 31 is broken, and the axle hole portion 15s and axle portion 16d are disengaged from the groove portion 2a1. As a result, even though the operating pressure angle between the flange gear 9c and driving gear 31 is directed diagonally downward in relation to the horizontal line, the process cartridge B can be smoothly pulled out.

On the contrary, in the case of the prior structure in which the process cartridge B is installed in the top lid 1b assembly, when the operating pressure angle is set diagonally downward relative to the horizontal line, the flange gear 9c and driving gear 31 remain engaged when the top lid 1b is opened. As a result, the process cartridge B cannot be smoothly pulled out. Therefore, the driving gear 31 must be provided with a one-way clutch or the like. However, in the case of this embodiment, when the top lid 1b is opened, the flange gear 9c is automatically disengaged from driving gear 31, which eliminates the need for the provision of the one-way clutch, allowing thereby the component count to be reduced.

Also, when the process cartridge B is lifted, and the axle hole portion 15s and axle portion 16d are disengaged from the groove portion 2a1, as described previously, the process cartridge B is pushed diagonally upward in the same direction as that in which the process cartridge B is pulled out from the cartridge installation space 2, by the pressure from the spring 24f exerting the pressure for closing the shutter mechanism 24. Therefore, it becomes easier to remove the process cartridge B.

As described in the foregoing, when the top lid 1b is opened, the process cartridge B is slightly lifted in the removal direction, by the upward force generated by the transferring roller 6, contact pins 27a, 27b, and 27c, and shutter mechanism 24; therefore, it can be smoothly and easily taken out.

{Recycling Procedure for Process Cartridge}

The process cartridge B which can be removed as described in the foregoing is constructed so as to be recyclable. Hereinafter, its recycling procedure will be described. After the toner in the toner storage 12a is depleted, the process cartridge B in this embodiment can be recycled to conserve global resources and protect the natural environment, wherein the top and bottom frames 14 and 15 are separated and the toner is refilled in the toner storage 12a.

More specifically, referring to Figures 7, 8, 37, and 38, the top and bottom frames 14 and 15 can be separated by disengaging the engagement claw 14a and engagement opening 15a, engagement claw 14a and engagement projection 15b, engagement claw 14c and engagement opening 15d, engagement claw 15c and engagement opening 14b, and engagement claw 14e3 and engagement opening 15f3. Referring to Figure 70, this disengagement procedure can be easily carried out by placing the spent process cartridge in a disassembling tool 32 and pushing the engagement claw 14a by sticking out a rod 32a. Also, the process cartridge B can be disassembled by pressing the engagement claws 14a, 14c, 15c, and 14e3, instead of using the disassembling tool 32.

After the process cartridge B is disassembled into the top frame 14 assembly and bottom frames 15 assembly as shown in Figures 7 and 8, the components are cleaned by blasting air or the like upon them for removing the waste toner adhering to the in-

terior of the cartridge, wherein a relatively large amount of waste toner will be found adhering on the photosensitive drum 9, developing sleeve 12, and cleaning means since they are the members which directly come in contact with the toner, whereas the degree of waste toner adhesion is less on the charging roller 10 since it is the member which does not directly come in contact with the toner. Therefore, the charging roller 10 can be easily cleaned compared to the photosensitive drum 9, cleaning means, or the like. In addition, in this embodiment, the charging roller 10 is disposed in the top frame 14 which can be separated from the bottom frame 15 in which the photosensitive drum 9, developing sleeve 12d, and cleaning means 13 are disposed; therefore, the top frame 14 separated from the bottom frame 15 can be easily cleaned.

Referring to Figure 60(b), the process cartridge B is separated into the top frame 14 assembly and bottom frame 15 assembly, and each assembly is further disassembled for more cleaning. More specifically, the top frame 14 assembly is disassembled into the top frame 14, charging roller 10, and the like, and the bottom frame 15 assembly is disassembled into the photosensitive drum 9, developing sleeve 12d, developing blade 12e, cleaning blade, and the like. In other words, the process cartridge B is disassembled to the level of individual components to be cleaned; therefore, the cleaning line becomes a simple one.

After the cleaning of the waste toner or the like, the opening 12a2 is sealed by pasting the cover film 26 with a tear tape 25 over the opening 12a2; a new supply of toner is filled through a toner filling mouth 12a4 provided on the side surface of the toner storage 12a; and the toner filling mouth 12a4 is covered with the cover 12a3. Then, the top and bottom frames 14 and 15 are joined by engaging the engagement claw 14a and engagement opening 15a, engagement claw 14a and engagement projection 15b, engagement claw 14c and engagement opening 15d, engagement claw 15c and engagement opening 14b, and engagement claw 14e3 and engagement opening 15f3, refinishing thus the process cartridge B for another round of use.

When the top and bottom frames 14 and 15 are joined, the engagement claw 14a is engaged with the engagement opening 15a; the engagement claw 14a, with the engagement projection 15b; and so on. However, it is conceivable that as the recycling count of the process cartridge B increases, the engagement claws and engagement openings eventually fail to engage. Therefore, in this embodiment, screw holes are provided at locations adjacent to respective engagement claws and engagement openings or locations where effects equivalent to those of the engagement claws and engagement openings can be obtained, so that the top and bottom frames can be screwed together. For example, the screw holes 14a1 are provided adjacent to the corresponding engagement claws 14a of the developing means 12 disposed in the top frame 14, and the screw holes 15a1 are provided adjacent to the engagement openings 15a provided in the bottom frame 15, that is, at locations which correspond to those of the screws 14a1. In addition to these screw holes, through holes are also provided adjacent to respective corners of the frames, being drilled through the engagement projection 14d and engagement concavity 15e (on the cleaning means side), and through the engagement projections 15f1 and 14e2 and the engagement concavity 14e1 (on the developing means side). Therefore, even when these engagement claws do not effectively engage, the top and bottom frames 14 and 15 can be tightly joined by screwing them together with screws fitted through these screw holes.

ANOTHER EMBODIMENT

Next, alternative embodiments of various portions in the image forming apparatus and process cartridge will be described referring to drawings, wherein the portions having the same functions as those in the first embodiment described hereinbefore will be designated by the same reference symbols.

(Image Bearing Member)

In the first embodiment, organic semiconductor (OPC) is used as the material for the photosensitive layer of the image bearing member, but the material is not limited by this example. For example, the material may be amorphous silicon (A-Si), selenium (Se), zinc oxide (ZnO), cadmium sulfide (CdS), or the like.

<Flange Gear>

In the first embodiment, the reinforcing member 9c4 is press-fitted into the hollowed portion 9c3 of the flange gear 9c as shown in Figure 9, as a means for preventing the flange gear 9c from being deformed by the load exerted on as the driving force is transmitted, but the present invention is not limited by this example. Just adding ribs or the likes to the flange gear itself, instead of press-fitting the reinforcing member 9c4, will do as long as satisfactory strength can be obtained. For example, a flange gear structured as shown in Figure 71 is one of such gears.

It has been stated previously that because the flange gear 9c is made of plastic material by ejection molding, it is hollowed below the bottom land of the gear portion. When the ribs are provided within this hollowed portion 9c3 shown in Figure 9, it is liable to invite the deterioration of the gear accuracy. Therefore, in the case of the flange gear 9c in this embodiment, the hollowed portion 9c is molded narrower so that the walls 9c6 are disposed below the bottom land

of the gear portion, and at the same time a large number of ribs 9c7 are provided in the hollowed portion 9c. With this arrangement, the strength of the flange gear 9c can be increased without inviting deterioration of the gear accuracy.

<Drum Axle>

In the first embodiment, the screw hole 9d1 is provided on the end surface of the drum axle 9d, as an exemplary means for simplifying the operation for disassembling the drum axle 9d having been press-fitted in the axle hole portion 15s of the bottom frame 15, but the present invention is not limited by this example. Any means will do as long as it is structured to make it easier to extract the drum axle 9d.

For example, a notch 9d2 may be provided on the drum axle 9d and axle hole portion 15s of the bottom frame 15 as shown in Figure 72(a), or an external diameter Rb of the flange portion 9d3 may be made larger than an external diameter Ra of the axle hole portion 15s of the bottom frame 15 as shown in Figure 72(b), whereby the drum axle 9d can be easily extracted. Further, in this embodiment, the thread cutting cost can be eliminated, reducing thereby the manufacturing cost.

(Charging Means)

<Sliding Bearing)

In the first embodiment, the hook-shaped stopper portion 10c1 is integrally formed on the sliding bearing 10c, as the thrust regulating means for regulating the force in the thrust direction of the charging roller 10, as shown in Figures 18 and 19, but the present invention is not limited by this arrangement. All that is needed is to have the thrust regulating portion to be integrally formed on the sliding bearing.

For example, a wall may be integrally molded, covering completely one end of the sliding bearing 10c as shown in Figure 73(a), to be used as the stopper portion 10c1, or instead, a projecting rib 10c2 may be provided on the interior wall of the stopper portion 10c1 as shown in Figure 73(b) so that the frictional resistance can be reduced when the end of the roller shaft of the charging roller 10 rotates while remaining in contact with the stopper portion.

Further, in the embodiment described in the foregoing, the stopper portion 10c1 is integrally formed, as an exemplary thrust regulating means, on the sliding bearing 10c which rotatively supports the charging roller 10, but the present invention is not restricted by this example. The same effects can be obtained when the thrust regulating means is provided for the transferring roller or the like.

As for the structure of the charging means, so-called contact type charging method is employed in the first embodiment, but it is needless to say that the drum surface may be uniformly charged by employing such a charging method that a metallic shield such as aluminum shield or the like is placed adjacent to a tungsten wire in a manner to shield it on three sides, and the positive or negative ions generated by applying a high voltage to the tungsten wire are transferred onto the surface of the photosensitive drum.

Further, the contact type charging means may be of a blade type, (charging blade), pad type, black type, rod type, wire type, or the like, in addition to the roller type described in the foregoing.

(Developing Means)

As for the developing method, it is possible to use various known developing methods such as the two-component magnetic brush developing method, cascade developing method, touch-down developing method, cloud developing method, or the like.

(Cleaning Means)

<Cleaning Blade>

In the first embodiment, the rib 14j is provided, as a means for suppressing the noise generated by the vibration of the cleaning blade, at a predetermined location on the internal surface of the top frame 14 as shown in Figures 31 and 32, and this rib 14j is abutted on the upper surface of the blade supporting member 13a1, with the seal member S1 being interposed, but the present invention is not limited by this example. For example, the rib 14j may be abutted on the slanted surface of the blade supporting member 13a1 supporting the blade 13a as long as such an arrangement can suppress the vibration of the blade 13a.

Further, a shock absorbing member 33 made of chloroprene rubber or the like may be sandwiched between the blade supporting member 13a1 to which the cleaning blade 13 is affixed and the top frame 14, as shown in Figure 75, wherein the seal member S1 is placed next to the shock absorbing member 33, to prevent waste toner leak. The thickness measurement of the shock absorbing member 33 used in this example is approximately 0.5 mm - 1.5 mm larger than that of the gap between the upper surface of the blade supporting member 13a1 and the internal surface of the top frame 14, and its measurement in the longitudinal direction is approximately 150 mm - 220 mm. The interposition of this shock absorbing member 33 flexes the top frame 14 by approximately 0.5 mm - 1.0 mm. In other words, the shock absorbing member 33 presses upon the blade supporting member 13a1 by a force strong enough to flex the top frame 14, whereby the vibration generated by the stick slip of the cleaning blade is suppressed to reduce the noise which comes out of the process car-

tridge.

Also, the shock absorbing member 33 may be disposed in a manner so as to be interposed between the rib 14j of the top frame 14 and the blade supporting member 13a1, as shown in Figure 76, wherein the shock absorbing member 33 used in this embodiment is of urethane rubber having a thickness of 0.5 mm or less, and is compressed between the rib 14j and blade supporting member 13a1 during the cartridge assembly process, so that its thickness is reduced to approximately 0.3 mm and its hardness reaches approximately 60°. Therefore, the micro-vibration with a frequency of several tens of Hz or more generated by the stick-slip of the cleaning blade 13a can be suppressed. As a result, the generation of noise can be prevented, and also, images of good quality can be produced.

Further, the rib 14j provided at a predetermined location of the top frame member 14 may be placed directly in contact with the blade supporting member 13a as shown in Figures 77 and 78. The rib 14j shown in Figure 77 is placed so as to contact substantially across the entire upper surface of the blade supporting member 13a1, and the rib 14j shown in Figure 78 is placed so as to contact substantially the entire surface area (upper and angled surface) of the blade supporting member 13a1. This arrangement increases the rate of vibration transmission from the cleaning blade 13a to the cartridge frame through the rib 14j, but it also increases the mass of the vibrating object itself (mass of the cartridge frame), whereby the vibration from the cleaning blade 13a is dissipated throughout the cartridge frame, that is, the larger mass. Therefore, the vibration of the blade 13a can be reduced, and subsequently, the noise generated by the vibration is reduced.

Further, such an arrangement as shown in Figure 79 may be made so that the top frame 14 is provided with an opening 34 which extends in the longitudinal direction of the cartridge, right next to where the cleaning blade 13a is (where the rib 14j could have been), and the top lid 1b on the apparatus main assembly side is provided with an abutment member 35, which is disposed at a predetermined location and comes to abut on the upper surface of the blade supporting member 13a1 through the opening 34 as the top lid 1b is closed. This arrangement causes the vibration of the cleaning blade to be transmitted throughout the entire apparatus by way of the abutment member 35, wherein the mass of the object itself to be vibrated is further increased (mass of the entire apparatus) and the vibration from the cleaning blade 13a is dissipated throughout the increased mass, that is, the mass of the entire apparatus, whereby the vibration of the blade 13a is reduced, and subsequently, the noise generated by the vibration is reduced. In addition, in order to improve the tightness of the contact, thin and soft shock absorbing material such as rubber sheet may be interposed between the blade supporting member 13a1 and abutment member 23.

Referring to Figure 80, when the blade supporting member 13a1 is fixedly screwed onto the cartridge frame, it may be screwed not only at both longitudinal ends of the angled surface but also at both longitudinal ends of the upper surface. Just like the preceding embodiment, this arrangement can suppress the micro-vibration with a frequency of several tens of Hz or more generated from the frictional force between the photosensitive member 9 and cleaning blade 13a, whereby the generation of the noise is eliminated, and also, images of good quality can be produced.

Further, in the case of a single-piece cleaning means such as shown in Figure 81, the same effects as that of the preceding embodiment can be obtained by screwing fixedly the blade supporting member 13a1, at the center portion of the upper surface.

Further, a rib 14j, which is slightly taller than the gap between the internal surface of the top frame 14 and the upper surface of the blade supporting member 13a1 and extends in the longitudinal direction of the cartridge, may be provided at the middle of the internal surface of the top frame 14, so that the elastic deformation, which occurs as the rib 14j is pressed upon the blade supporting member 13a1, can be used to press the upper surface of the blade supporting member 13a1. By this arrangement, the rib 14j is pressed upon the upper surface of the blade supporting member 13a1 by the elastic deformation of the top frame 14, and by this pressure, the vibration of the cleaning blade 13 can be suppressed, whereby the noise from the vibration is reduced.

Further, the same effects as that of the preceding embodiment can be obtained by providing a partitioning wall 36, which is slightly taller than the gap between the bottom portion of the wast toner storage 13c and the upper portion of the blade supporting member 13a1, within the waste toner storage 13c of the bottom frame 15, at the center portion in the longitudinal direction of the cartridge. In this case, the strength of the bottom frame 15 is also improved by the provision of this partitioning wall 36.

By implementing one or more of these embodiments described hereinbefore, the micro-vibration with a frequency of several tens of Hz or more generated by the friction force between the photosensitive drum 9 and cleaning blade 13a can be suppressed, wherein after the implementation of the embodiment, the amplitudes of vibrations of both photosensitive drum 9 and cleaning blade 13a drop to 0.01 μm or below, which are within the measurement error, whereby the noise generated by the vibration is eliminated, and images of good quality are produced, whereas before the implementation of the embodiment, they are approximately 4 μm - 5 μm, respectively.

As regards a method for cleaning the residual to-

ner on the photosensitive drum 9, the cleaning means may be constituted by a blade, fur brush, magnetic brush, or the like.

(Top and Bottom Frames)

In the first embodiment, the driving portion on the development side of the bottom frame 15 is molded substantially in a box shape, and in addition, ribs are provided for increasing the local strength of the frame. The same method can be applied to increase other portions of the top and bottom frames.

(Shutter Mechanism)

In the first embodiment, the shutter mechanism 24 is designed to be automatically opened as the process cartridge B is installed, and to be automatically closed by the torsional coil spring as the cartridge B is pulled out. Therefore, when the process cartridge B is in the image forming apparatus, the shutter mechanism 24 is pressured in the closing direction by the spring 24, whereby the process cartridge B is pressured in the direction in which the process cartridge B is to be lifted out of the cartridge installation space 2 of the apparatus main assembly, which is one of the advantages of such a design. However, when the pressure from the torsional spring 24 is too strong, the process cartridge B becomes positionally unstable. Therefore, a locking mechanism may be provided for locking the shutter mechanism 24 when the shutter mechanism 24 is opened.

As for the locking mechanism, referring to Figure 84, a lever 39b pressured by a compression spring 39a is provided at a predetermined location of the process cartridge B, wherein this lever engages into an engagement hole 24c2 provided on the shutter portion 24c when the shutter mechanism opens all the way. By this arrangement, the shutter mechanism 24 is locked in the open state; therefore, the pressure from the torsional spring 24f is prevented from working to lift the process cartridge B.

The locked shutter mechanism is released by an eject button 40 shown in Figure 84. More specifically, the apparatus main assembly is provided with the eject button 40, which is pressured by a compression spring 40c in the direction to stick out of the apparatus main assembly. As this ejection button 40 is pressed, a pressing projection 40a located at the end of the button pushes in the lever 39b, whereby the lever 39b is disengaged from the engagement hole 24c2, releasing thereby the shutter mechanism from the locked state.

The eject button 40 is provided with an engagement claw 40b. When the top lid 1b is closed, this engagement claw 40b engages with the engagement hook 41 provided on the top lid 1b, locking thereby the top lid 1b in the closed state. On the other side, when the eject button 40 is pressed, the engagement is broken and the top lid 1b is opened by the pressure from the torsion coil spring provided at the rotational center of the top lid 1b. In other words, as the ejection button 40 is pressed, the top lid 1b is automatically opened, and at the same time, the process cartridge B is lifted, as if floating out of the cartridge installation space 2, by the pressure from the spring 24f, which makes it easier to take out the process cartridge B.

Referring to Figures 85 - 89, the pressure which is provided by the drum shutter in the first embodiment can be provided by an alternative structure, which is totally different from that in the first embodiment. Hereinafter, the structure of the alternative structure shown in Figures 85 - 89 will be described.

In this embodiment, a process cartridge 42 shown in Figure 85 is installed in the image forming apparatus 43 by inserting it through an inserting window 44 provided in front of the apparatus. The process cartridge 42 and image forming apparatus 43 have the same functions as those of the first embodiment, and the process cartridge 42 comprises a cartridge main assembly 42a and a case 42b which functions as the shutter mechanism.

The cartridge inserting window 44 is blocked with a thin plate 46 imparted with the pressure from a spring 45 in the closing direction, and this thin plate 46 is pushed open by the process cartridge 42 to be inserted. The process cartridge 42 is inserted until its flange portion 42c becomes substantially level with the front surface of the image forming apparatus main assembly. As the cartridge main assembly 42a is pushed in further, the case 42b remains where it is. As a result, a forward portion of the cartridge main assembly 42a is projected out of the process cartridge 42. Then, the projected cartridge main assembly 42a is detected by an unshown sensor, and a gear 47 engaged with an unshown motor begins to rotate.

The gear 47 engages with a rack 42a1 provided on the top surface of the cartridge main assembly 42a, and the cartridge main assembly 42a is pulled out further from the case 42b by the rotation of the gear 47. At this time, an axle 48 that is the extension of the axle of the photosensitive drum contained in this cartridge main assembly engages into a guide groove 49 provided within the image forming apparatus 43, being thereby guided forward by this guide groove 49. Referring to Figure 88, a contact 50 for making an electrical contact is provided at the rear (left side in Figure 88) of the cartridge main assembly 42a. As the cartridge main assembly 42a is further pulled out, the contact 50 comes in contact with a contact pin 52 which is provided on the image forming apparatus 43 side and is under downward pressure from a spring 51. At this time, the cartridge main assembly 42a is subjected to the downward pressure from the contact pin 52, and as a result, the rear portion of the cartridge main assembly 42a slightly drops down

along the guide groove 49.

Also, as the process cartridge 42 is inserted, a shaft 53 provided on the image forming apparatus 43 side is projected into a hole 24b1 of the case 42b. This shaft 53 is pressured by a compression spring 55, by way of a lever 54, in the direction to be projected into the hole 42b1, wherein the lever 54 is exposed outward the image forming apparatus 43. When the cartridge main assembly 42a is further pulled out to a predetermined point, the shaft 53 drops into a concave 42a2 provided on the side surface of the cartridge main assembly 42a, whereby the cartridge main assembly 42a is locked at this location against the pressure of a tension spring 42d working to pull the cartridge main assembly 42a back into the case 42b. In other words, in this locked state, the force of the tension spring 42d is prevented from working to move the cartridge main assembly 42a out of the normal position; therefore, the process cartridge 42 is positionally stabilized in the image forming apparatus.

The lever 54 is pivotable about an axis 54a, and when a force is exerted in the direction of an arrow in Figure 89, the shaft 53 is pushed out of the concave 42a2 by the pressure from the tension spring 42d, and the cartridge main assembly 42a is pulled back into the case 42b. During this pull-back, since the gear 47 and rack 42a1 remain engaged, the gear 47 serves as a damper to prevent the cartridge main assembly 42a from being snappingly pulled back into the case 42b.

After the cartridge main assembly 42a has been pulled back into the case 42b, the cartridge main assembly 42a protrudes a predetermined amount from the image forming apparatus 43 as shown in Figure 87, making it easy to pull it out.

As described in the foregoing, the provision of the tension spring 42d with an adequate force for pulling back the cartridge main assembly 42a into the case 42b, as well as the provision of the locking mechanism, make it extremely easy to take out the cartridge 42.

Further, with this arrangement in place, the installation related status of the cartridge 43 can be monitored by observing the condition of the lever 54. More specifically, referring to Figure 90, when the process cartridge 42 is not in the image forming apparatus 43, the lever 54 looks as shown in Figure 90(a); when the process cartridge 42 has been properly installed and the shaft 53 has dropped into the concavity 42a2, it looks as shown in Figure 90(b); and when the cartridge 42 has been improperly installed in the image forming apparatus 43, it looks as shown in Figure 90(c). Therefore, the installation related status of the cartridge can be determined just by observing externally the position of the lever 54.

{Process Cartridge Structure and Assembly Process}

<Seal at End of Cleaning Blade>

In the first embodiment, as a means for reducing the frictional force between the end portion of the photosensitive drum 9 and the seal member S6 pasted on the bottom portion of the blade attachment surface 15j, which corresponds to the end portion of the cleaning blade 13a, the high density polyethylene seal 37 is pasted on the seal member S6 as shown in Figure 49, or lubricant 38 such as micro-particle of silicon is coated on the seal member S6 as shown in Figure 50, but the present invention is not limited by this example. Powder material such as polyfluorovinylidene particles or the like may be used as the lubricant 38.

As for a method for adhering the powder lubricant 38 onto the seal member S6, the lubricant 38 may be just sprinkled on the seal member S6 when the frictional force between the seal member S6 and the end portion of the photosensitive drum 9 is not relatively large. This is because when the drum 9 is in the early stage of its usage, the surface of the seal member S6 is rough and its friction is large, whereas after a certain period of usage, the roughness of the surface of the seal member S6 is reduced and the friction is also reduced.

Further, the powder lubricant 38 may be dispersed throughout the seal member 38, by such a method that powder lubricant 38 is mixed in volatile liquid; this mixture is soaked into the seal member 37; and then, the liquid is evaporated. This method allows the lubricant 38 having been dispersed throughout the seal member 37 to be exposed little by little at the contact surface between the photosensitive drum 9 and the seal member 37. As a result, the friction between the photosensitive drum 9 and seal member 38 is reduced for a long period of time, whereby the seal member 37 is prevented from being dragged and torn off by the photosensitive drum.

<Method for Installing Photosensitive Drum>

During the description of the first embodiment, one of the methods for installing the photosensitive drum 9 was introduced, in which in order to interpose the lubricant 38 throughout the contact surface between the photosensitive drum 9 and cleaning blade 13 at the beginning of the cartridge assembly process, the photosensitive drum 9 was inserted while being guided in the direction which formed an angle γ, which was less than 45°, relative to the contact surface of the blade 13a. This drum installation method may be adopted also for the recycling assembly process.

It is conceivable that the service lives of the va-

rious components used in the process cartridge are different. Let it be assumed that the service life of the photosensitive drum 9 is inferior to that of the cleaning blade 13a. In such a case, a spent process cartridge can be recycled by replacing only the cartridge main assembly 42a. When the photosensitive drum 9 is removed during the drum replacing operation, the residual developer is still adhering to the contact surface of the blade 13a, and this residual developer can serve as the aforementioned lubricant 38. However, generally speaking, when the photosensitive drum 9 is removed, this residual developer is divided between the surface of the photosensitive drum 9 and the contact surface of the blade 13a; therefore, the amount of the residual developer adhering to the blade 13a is not enough to cover the entire contact surface of the blade 13a.

Therefore, the drum installation method according to the present invention may be adopted, whereby, as a fresh photosensitive drum 9 is inserted into the process cartridge B, the residual developer on the blade 13a can be distributed to cover the entire contact surface between the blade 13a and photosensitive drum 9. In other words, the residual developer can be interposed as the lubricant between two components.

Further, the present invention can be preferably applied not only to a process cartridge for monocolor image formation such as the one described hereinbefore, but also to a process cartridge in which two or more developing means 12 are provided for forming multicolor images (for example, dual-color images, triple-color images, full-color images, or the like).

The process cartridge B described hereinbefore refers to a process cartridge comprising an electrophotographic photosensitive member or the like as the image bearing member and at least one processing means. However, many other cartridge designs are possible beside those of the embodiments described hereinbefore. For example, the process cartridge B is available in the form of an exchangeable process cartridge in which: an image bearing member and a charging means are integrally assembled; an image bearing member and a developing means are integrally assembled; or an image bearing member and a cleaning means are integrally assembled. Further, the process cartridge B is also available in the form of an exchangeable process cartridge in which an image bearing member and two or more processing means are integrally assembled.

In other words, the process cartridge described hereinbefore refers to an exchangeable process cartridge for an image forming apparatus, comprising a charging means, developing means, and cleaning means, which are integrally assembled with an electrophotographic photosensitive member, in the form of a cartridge; comprising at least one of a charging means, developing means, and cleaning means, which are integrally assembled with an electrophotographic photosensitive member, in the form of a cartridge; or comprising at least a developing means, which is integrally assembled with an electrophotographic photosensitive member, in the form of a cartridge.

During the descriptions of the embodiments of the present invention, a laser beam printer is selected as an example of the image forming apparatus, but the present invention does not need to be limited by this choice. It is needless to say that the present invention is applicable to many other image forming apparatuses such as an electrophotographic copying machine, facsimile apparatus, LED printer, word processor, or the like.

According to the above-described embodiments, the conductive member for the developing bias voltage for supplying the developing bias voltage to the developing means and the conductive member for grounding the image bearing member, are disposed adjacent the same longitudinal end of the image bearing member in a direction perpendicular to a rotational direction of the image bearing member, and the conductive member for the charging bias voltage for supplying the charging bias voltage to the charging means is disposed adjacent the opposite side of the image bearing member, and in addition, the position of contact of the developing bias voltage conductive member, the position of contact of the grounding conductive member and the position of contact of the charging bias conductive member, are not overlapped in a direction of insertion of the process cartridge into the main assembly of the image forming apparatus, by which the electric power supply system to the process cartridge is simplified, and the electric contacts are free of influence of the mounting operation of the process cartridge, and the size reduction and cost reduction of the process cartridge and the image forming apparatus, can be accomplished.

As described in the foregoing, according to the present invention, the developing bias voltage application to the developing means, the charging bias voltage application to the charging means and the grounding of the image bearing member, can be accomplished with certainty, and therefore, the high quality images can be produced.

According to the embodiments, a developing bias voltage application to developing means, charging bias voltage application to charging means and electric grounding of the image bearing member, can be assuredly carried out, and therefore, high quality of the image can be assured. In an embodiment of the present invention, an electrically conductive member for supplying developing bias voltage and an electrically conductive member for grounding, are provided adjacent the same end portion of the image bearing member in a direction substantially perpendicular to a movement direction of the image bearing member,

and an electrically conductive member for supplying the charging bias voltage is provided adjacent the opposite side. Because of this structure, mutual influence can be reduced. Thus, the power supply system for the process cartridge is simplified, so that the size and cost of the process cartridge and the image forming apparatus can be reduced.

As described in the foregoing, the present invention provides a process cartridge and an image forming apparatus capable of assured establishing electric contact with a main assembly, when the process cartridge is mounted in a main assembly of an image forming apparatus.

According to another aspect of the present invention, there is provided a process cartridge and an image forming apparatus in which influence of a drive transmitting portion to an electrically conductive member is reduced.

According to a further aspect of the present invention, there is provided a process cartridge and an image forming apparatus in which liability of damage to an electric contact can be avoided.

According to a further aspect of the present invention, there is provided a process cartridge and an image forming apparatus in which wiring distance of electrically conductive member for developing bias and an electrically conductive member for charging bias, can be reduced.

While the invention has been described with reference to the structures disclosed herein, it is not confined to the details set forth and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

Claims

1. A process cartridge detachably mountable to a main assembly of an image forming apparatus, comprising:

   an image bearing member;

   process means actable on said image bearing member;

   a developing bias conductive member for permitting developing bias voltage application to developing means;

   grounding conductive member for electrically grounding said image bearing member;

   wherein said conductive members are disposed adjacent an end of said image bearing member in a direction perpendicular to a movement direction of said image bearing member; and

   charging bias conductive member for permitting application of charging bias to said charging means, provided adjacent an opposite end of said image bearing member.

2. A process cartridge according to Claim 1, wherein said developing bias conductive member and said grounding conductive member, are disposed adjacent the developing means, relative to said image bearing member.

3. A process cartridge according to Claim 1, wherein said charging bias conductive member is disposed adjacent cleaning means, relative to said image bearing member.

4. A process cartridge according to any one of Claims 1 - 3, wherein a drive transmitting portion for transmitting a rotational driving force to a photosensitive drum as said image bearing member, is disposed adjacent the opposite end.

5. A process cartridge according to Claim 4, wherein said drive transmitting portion includes a helical gear.

6. A process cartridge according to any one of Claims 1 - 3, wherein a contact position of said developing bias conductive member and a contact position of said grounding conductive member and a contact position of said charging bias conductive member, are deviated from a line along a movement direction of said image bearing member.

7. A process according to Claim 1, wherein said process cartridge is mounted in a main assembly of the image forming apparatus along a direction of movement of said image bearing member.

8. A process cartridge according to Claim 1 or 7, wherein said process cartridge is mounted in a main assembly of the image forming apparatus with cleaning means as said process means in front and the developing means at rear.

9. A process cartridge according to Claim 1, a contact position of said developing bias conductive member, a contact position of said grounding conductive member and a contact position of said charging bias conductive member, are not overlapped in a direction of insertion of said process cartridge in the main assembly of said image bearing member.

10. A process cartridge according to Claim 1, wherein said developing bias conductive member is more away from said image bearing member than said grounding conductive member.

11. A process cartridge according to Claim 1, wherein an exposed area of said grounding conductive member is larger than an exposed area of said

developing bias conductive member.

12. A process cartridge according to Claim 1, wherein a configuration of an exposed portion of said developing bias conductive member is semispherical on rectangular parallelepiped.

13. A process cartridge according to Claim 1, wherein a configuration of an exposed portion of said grounding conductive member is like a boot.

14. A process cartridge according to Claim 1, wherein an exposed part of said grounding conductive member extends from a position of a photosensitive drum as said image bearing member to an outside of the photosensitive drum.

15. A process cartridge according to Claim 1, wherein an exposed portion of said charging bias conductive member is bent.

16. A process cartridge according to Claim 1, wherein said developing bias conductive member and said grounding conductive member, are faced to a photosensitive material applied region of a photosensitive drum as said image bearing member.

17. A process cartridge according to Claim 1, wherein an exposed portion of said grounding conductive member extends from a position of a photosensitive drum as said image bearing member to outside of the photosensitive drum.

18. A process cartridge according to Claim 1, wherein said process cartridge integrally comprises charging means, developing means or cleaning means as the process means and an electrophotographic photosensitive member as the image bearing member, wherein said process cartridge is detachably mountable relative to the main assembly.

19. A process cartridge according to Claim 1, wherein said process cartridge integrally comprises an electrophotographic photosensitive member as the image bearing member and at least one of charging means, developing means and cleaning means as process means, wherein said process cartridge is detachably mountable relative to said image forming apparatus.

20. A process cartridge according to Claim 1, wherein said process cartridge comprises at least developing means as the process means and the electrophotographic photosensitive member as the image bearing member, and wherein said process cartridge is detachably mountable relative to the image forming apparatus.

21. An image forming apparatus for forming an image on a recording material, to which a process cartridge is detachably mountable, said apparatus comprising:

mounting means for mounting said process cartridge including an image bearing member; process means actable on said image bearing member; a developing bias conductive member for permitting developing bias voltage application to developing means; grounding conductive member for electrically grounding said image bearing member; wherein said conductive members are disposed adjacent an end of said image bearing member in a direction perpendicular to a movement direction of said image bearing member; charging bias conductive member for permitting application of charging bias to said charging means, provided adjacent an opposite end of said image bearing member;

a main assembly developing bias conductive member contactable with said developing bias conductive member;

a main assembly grounding conductive member contactable with said grounding conductive member; and

a main assembly charging bias conductive member contactable with said charging bias conductive member.

22. A process cartridge detachably mountable to a main assembly of an image forming apparatus, comprising:

an image bearing member;

developing means;

charging means;

cleaning means;

a developing bias conductive member for application of a developing bias voltage to said developing means, provided adjacent said developing means and adjacent an end of said image bearing member in a direction perpendicular to a movement direction of said image bearing member;

a grounding conductive member for electrically grounding said image bearing member;

a charging bias conductive member for application of a charging bias voltage to said charging means, adjacent said cleaning means.

23. A process cartridge according to Claim 22, wherein said developing bias conductive member and said grounding conductive member are adjacent to said developing means, relative to said image bearing member, and wherein said charging bias conductive member is adjacent said cleaning means, wherein a photosensitive drum as said image bearing member is provided with a helical gear for receiving rotational force from the

main assembly of said image forming apparatus, adjacent the other end of said image bearing member in a direction perpendicular to a movement direction of the photosensitive member.

24. An image forming apparatus for forming an image on a recording material, to which a process cartridge is mountable, comprising:

mounting means for mounting said process cartridge including an image bearing member; developing means; charging means; cleaning means; a developing bias conductive member for application of a developing bias voltage to said developing means, provided adjacent said developing means and adjacent an end of said image bearing member in a direction perpendicular to a movement direction of said image bearing member; a grounding conductive member for electrically grounding said image bearing member; a charging bias conductive member for application of a charging bias voltage to said charging means, adjacent said cleaning means;

a main assembly developing bias conductive member contactable with said developing bias conductive member;

main assembly grounding conductive member contactable with said grounding conductive member; and

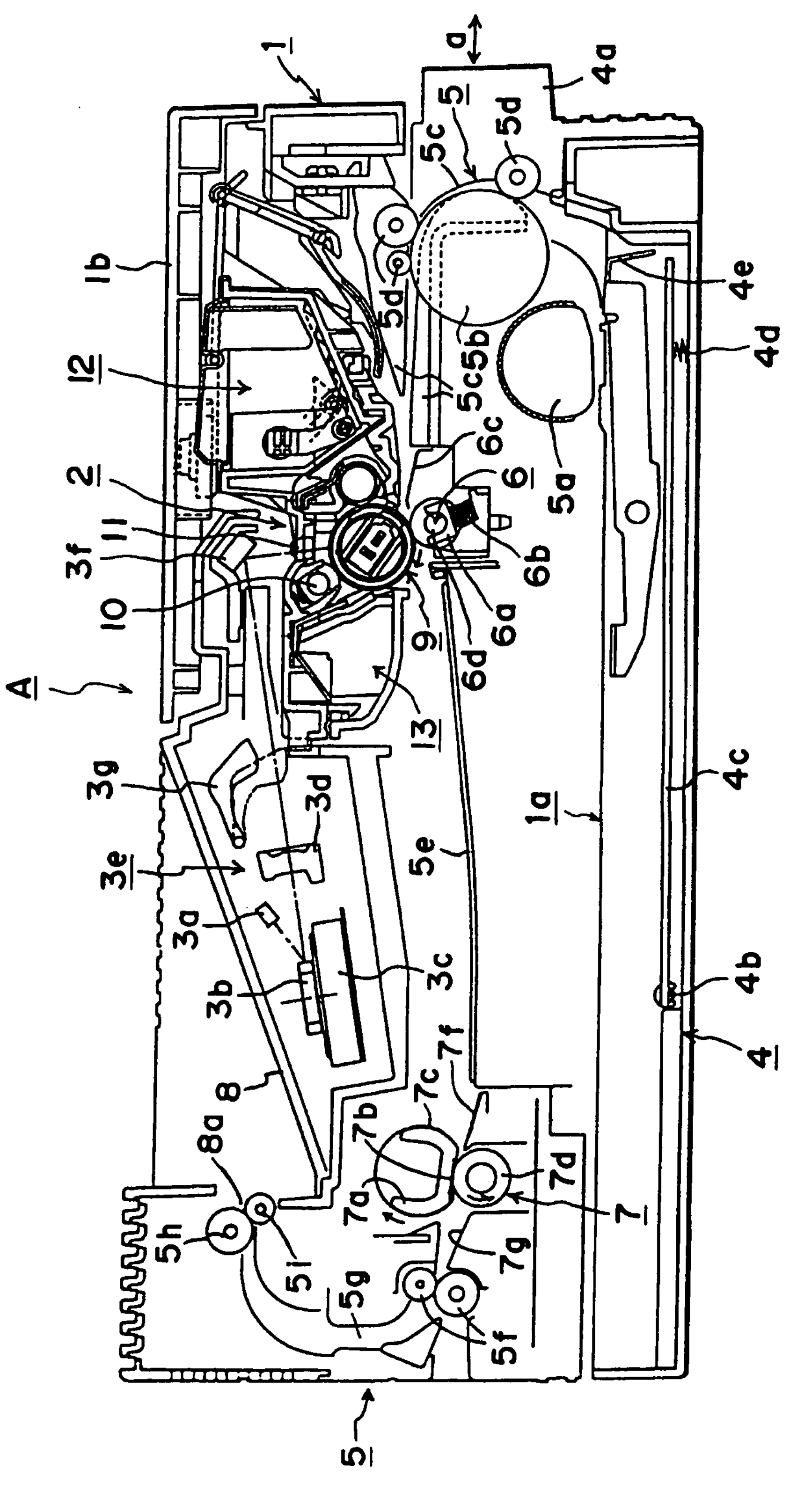
a main assembly charging bias conductive member contactable with said charging bias conductive member.

25. An apparatus according to either claim 21 or claim 24, wherein said image forming apparatus is an electrophotographic copying machine.

26. An apparatus according to either claim 21 or claim 24, wherein said image forming apparatus is a laser beam printer.

27. An apparatus according to either claim 21 or claim 24, wherein said image forming apparatus is a facsimile machine.

28. A process cartridge including a photosensitive member, means allowing a developing bias voltage to be applied to said member, and means allowing a charging bias to be applied to said member, said means being respectively located at opposite ends of said member.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5h
5i
5l
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6a
6b
6c
6d
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8a
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11
12
13
a

FIG. 1

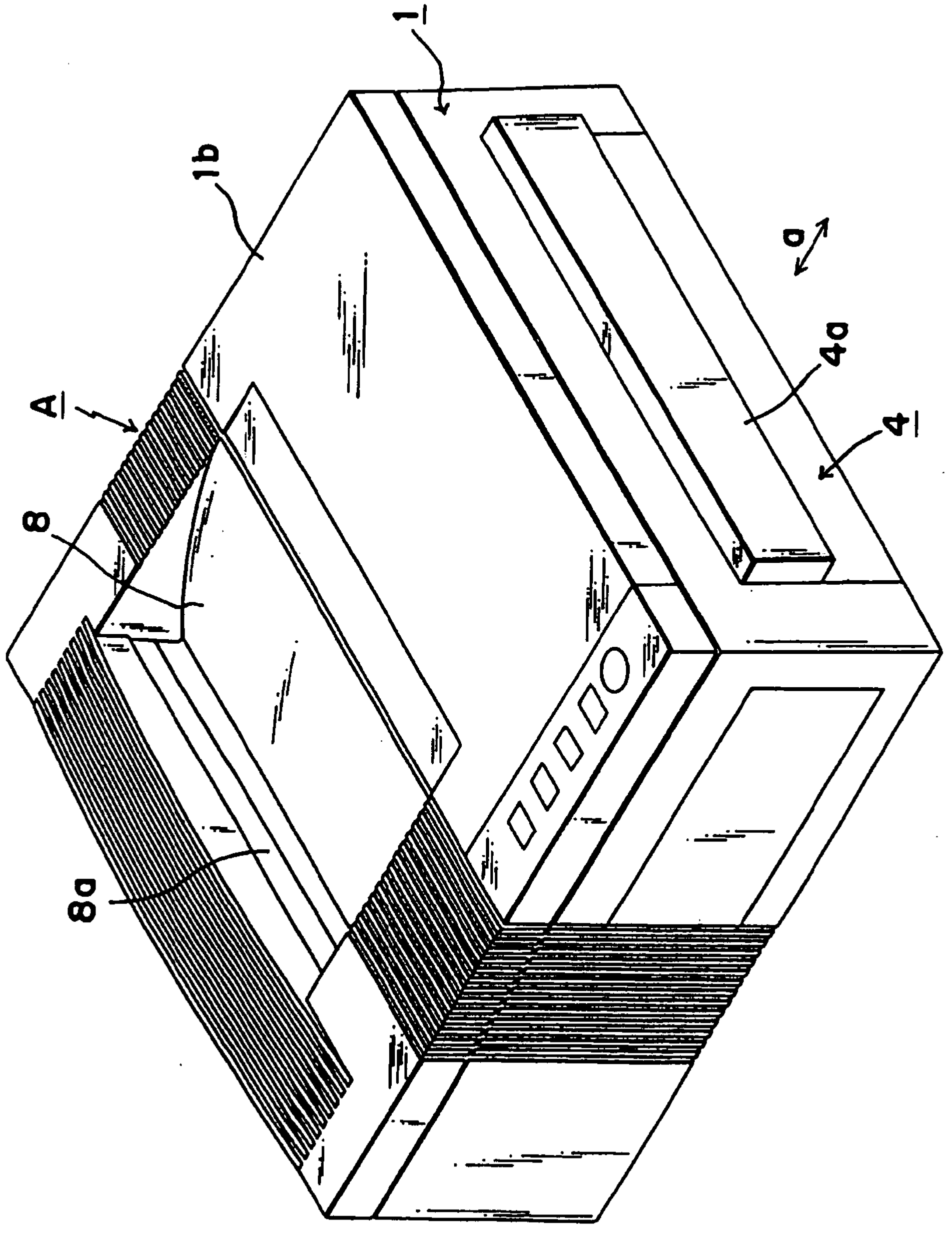
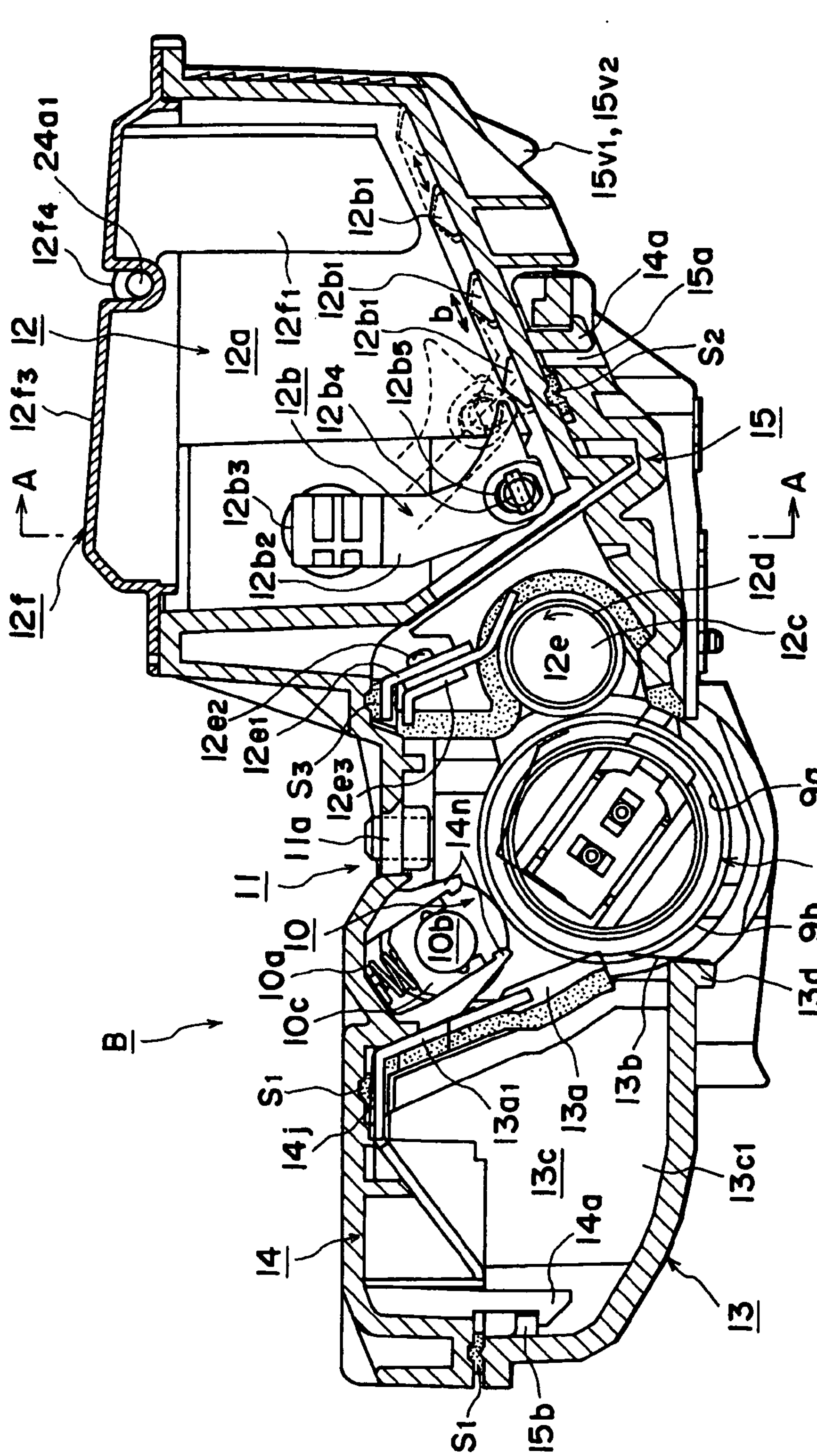


FIG. 2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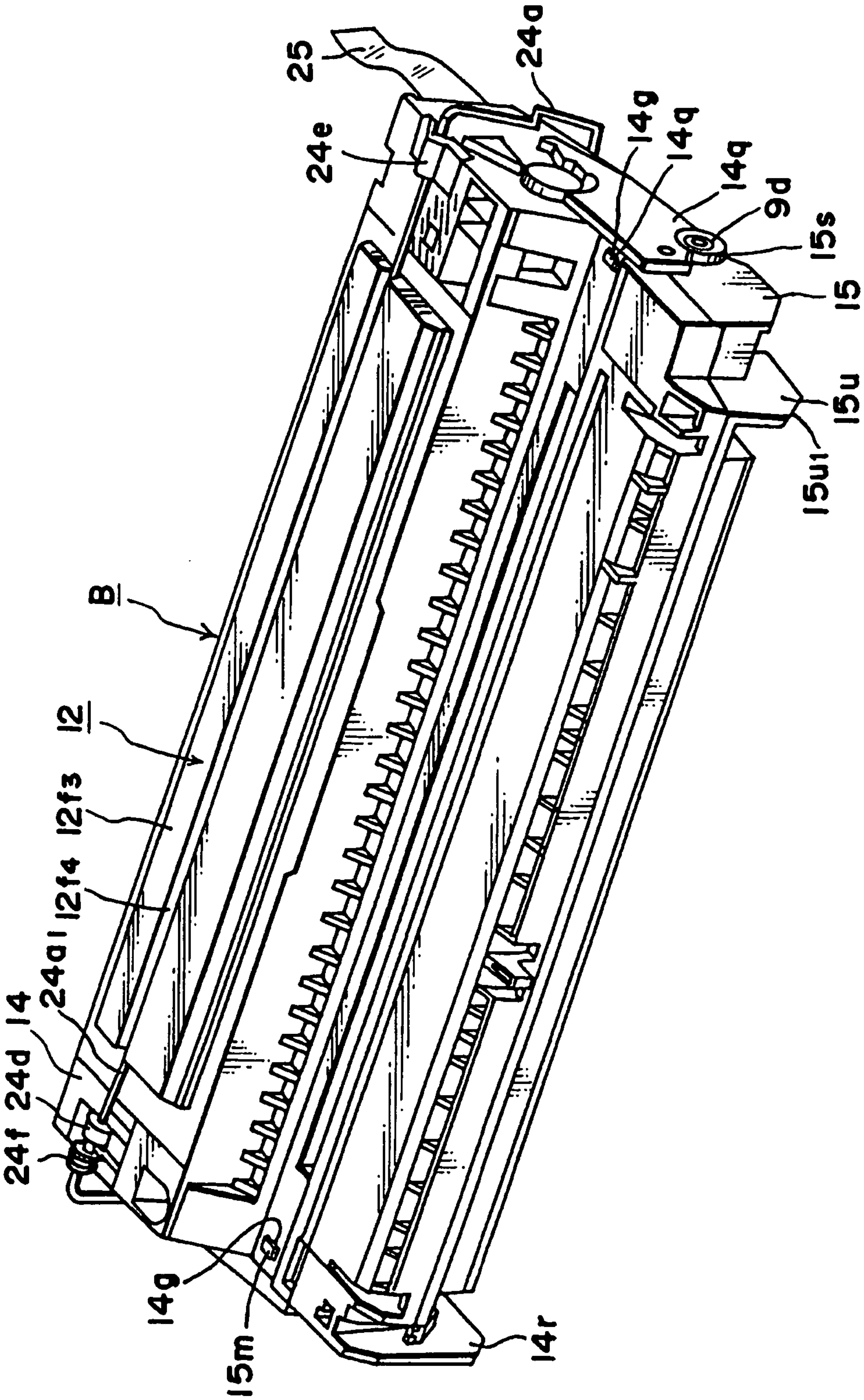
13
S1
15b

FIG. 3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14q
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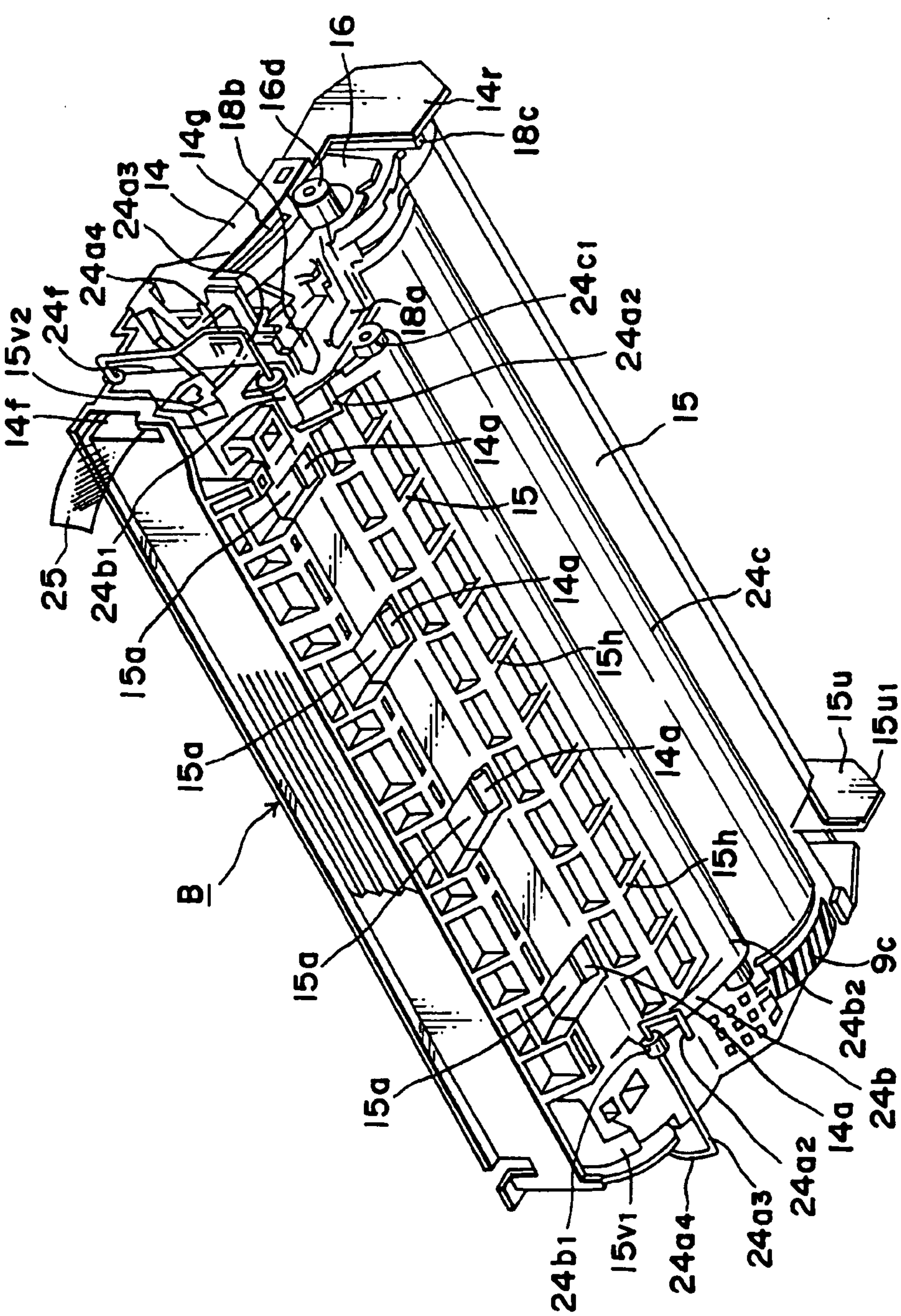
FIG. 4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14g
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24c
15a
14a
15h
15a
14a
15u
15u1
B
15h
15a
9c
24b2
15a
24b
14a
24a2
24a3
24a4
15v1
24b1

FIG. 5

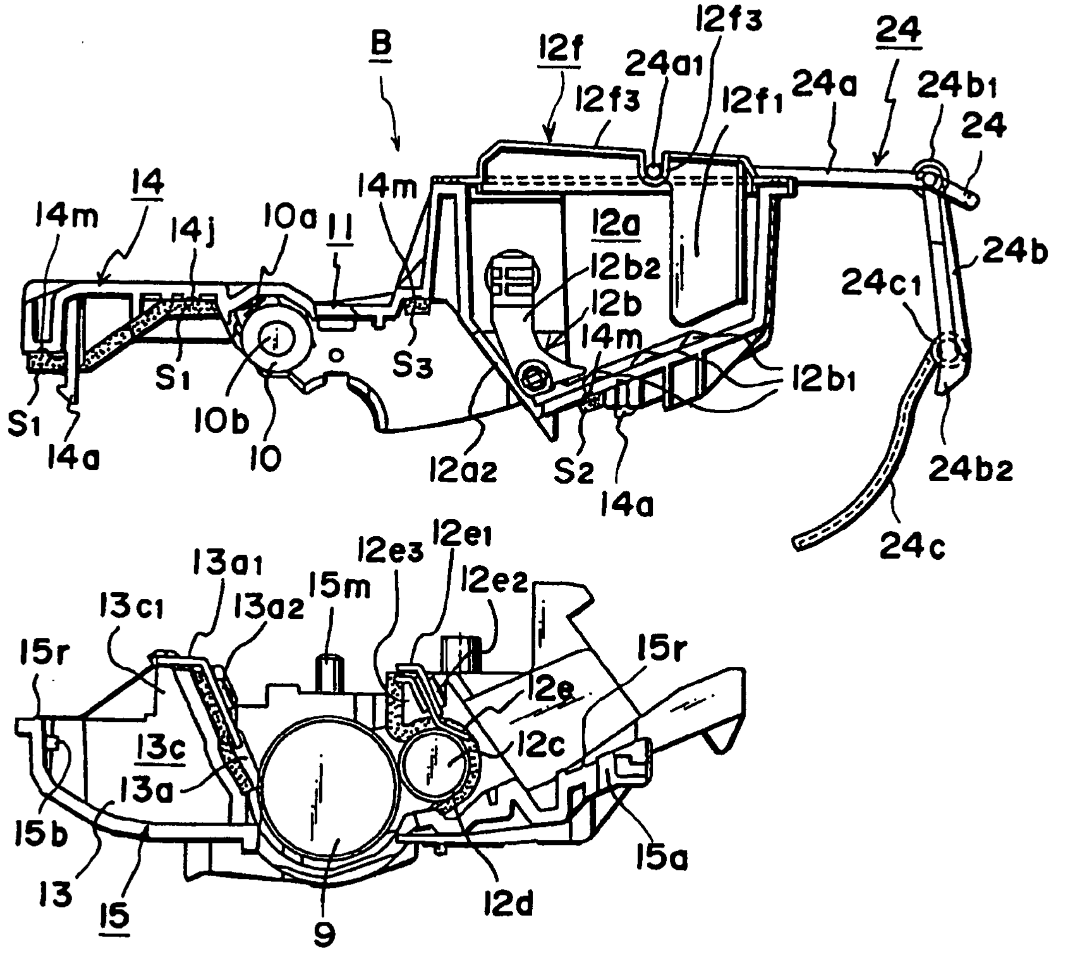

B
12f
12f3
24a1
12f3
12f1
24a
24
24b1
24
14
14m
14j
10a
11
14m
12a
12b2
12b
24b
24c1
S1
S1
14a
10b
10
S3
14m
12b1
12a2
S2
14a
24b2
24c
13a1
12e3
12e1
13c1
13a2
15m
12e2
15r
12e
15r
13c
12c
13a
15b
13
15
9
12d
15a

FIG. 6

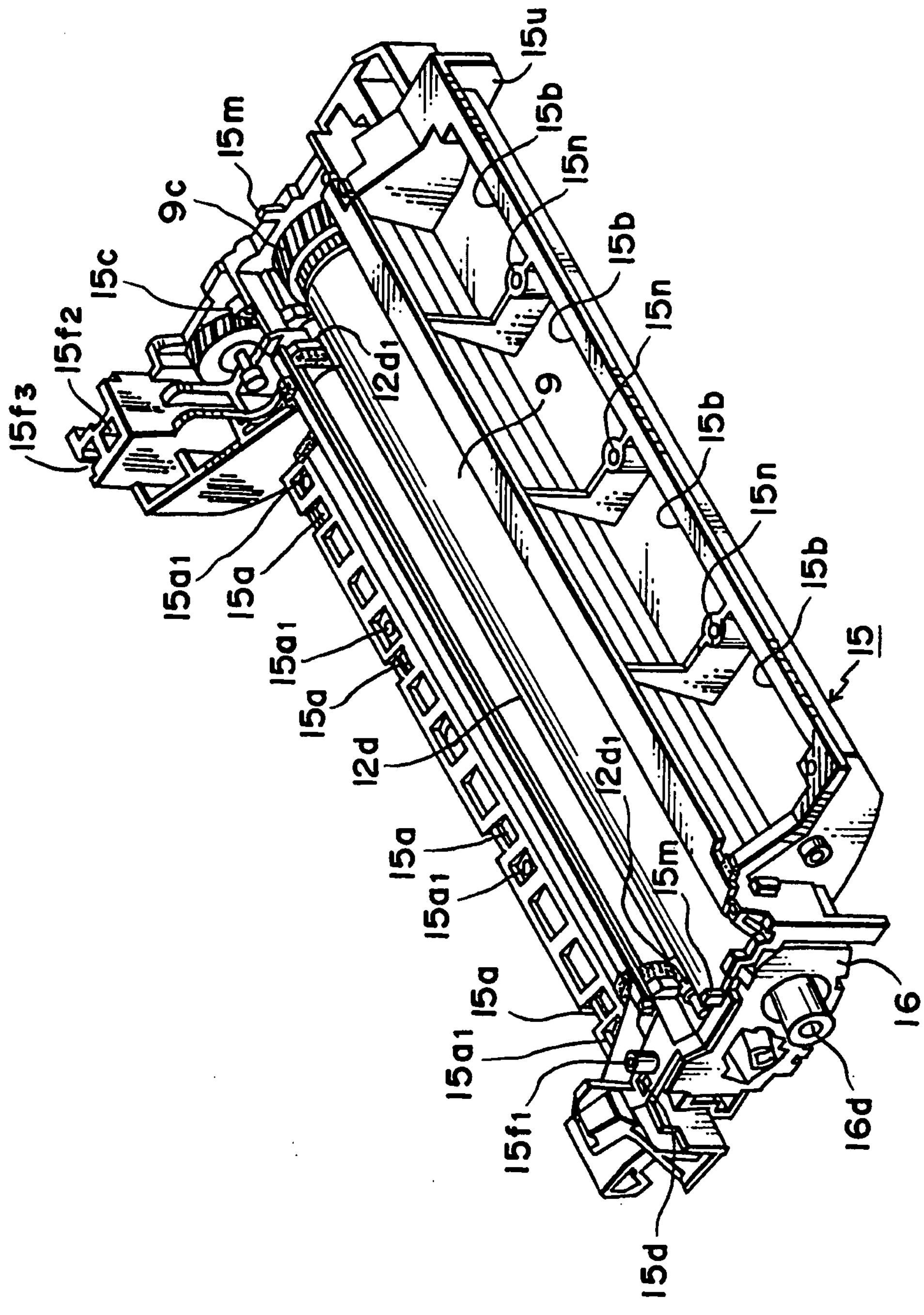

15u
15b
15m
9c
15n
15b
15c
15n
15f2
15f3
12d1
9
15b
15n
15a1
15a
15a1
15a
12d
15b
15
12d1
15a
15a1
15m
15a
15a1
15f1
16
16d
15d

FIG. 7

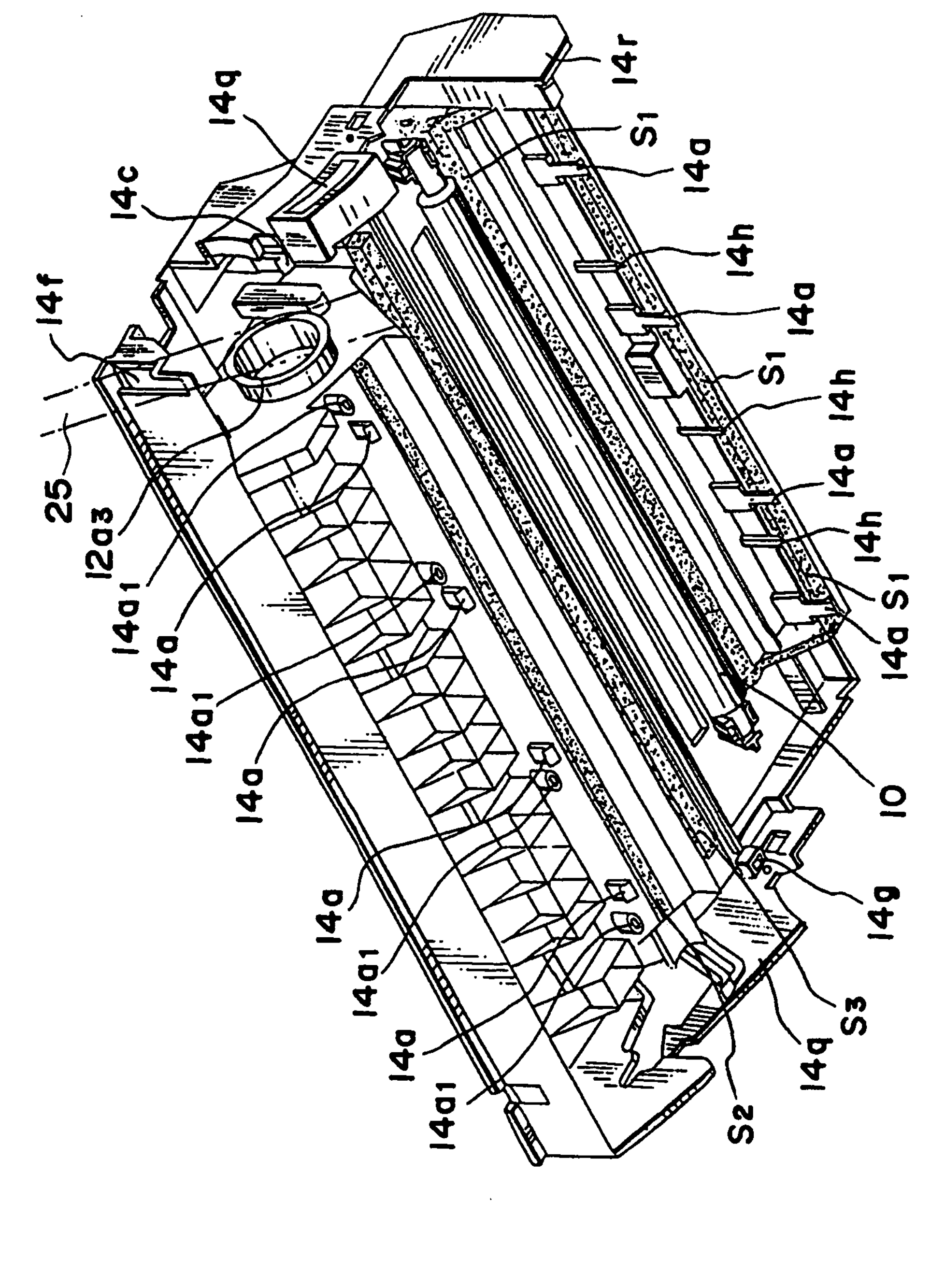

14r
14q
14c
14f
25
12a3
14a1
14a
14a1
14a
14a
14a1
14a
14a1
S1
14a
14h
14a
S1
14h
14a
14h
S1
14a
10
14g
S3
14q
S2

FIG. 8

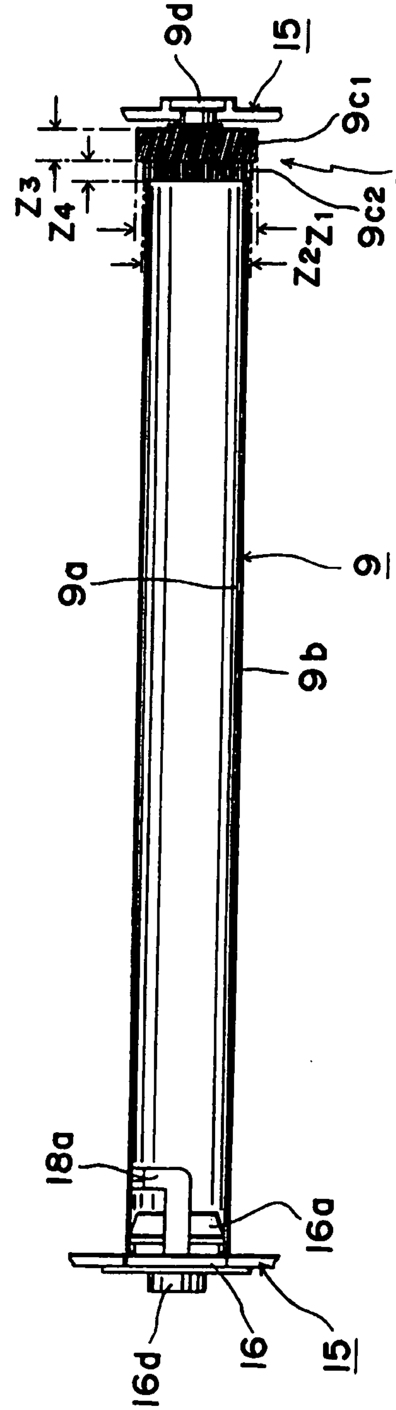
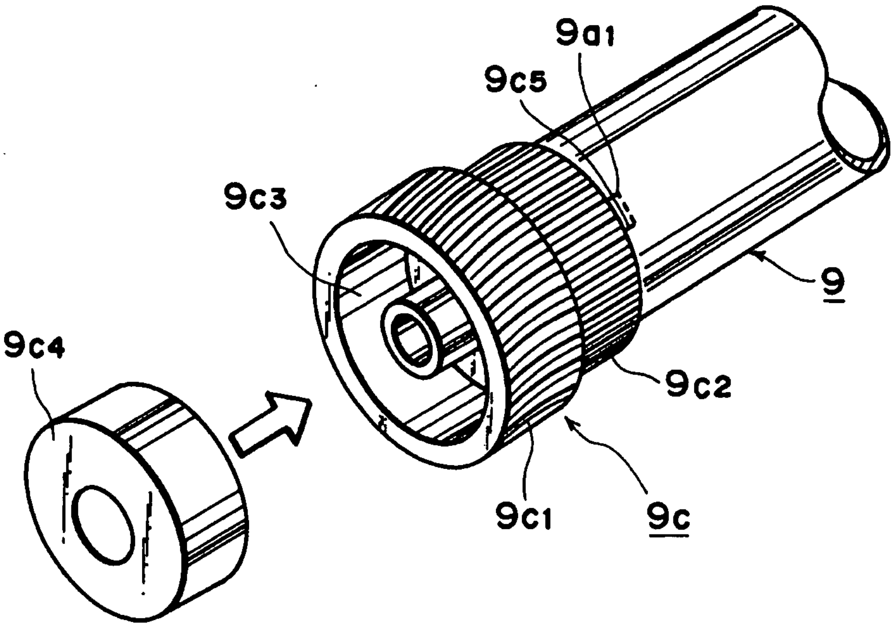


FIG. 9

(a)



(b)

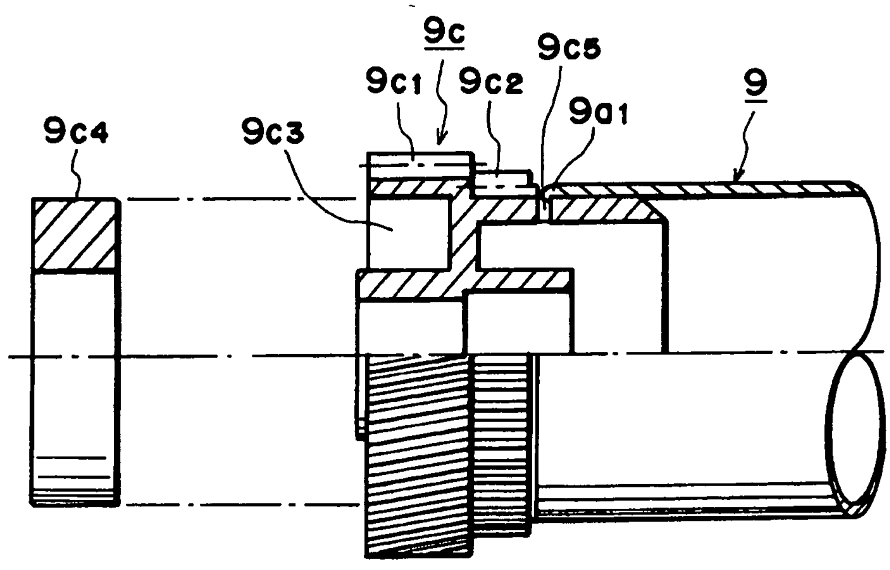


FIG. 10

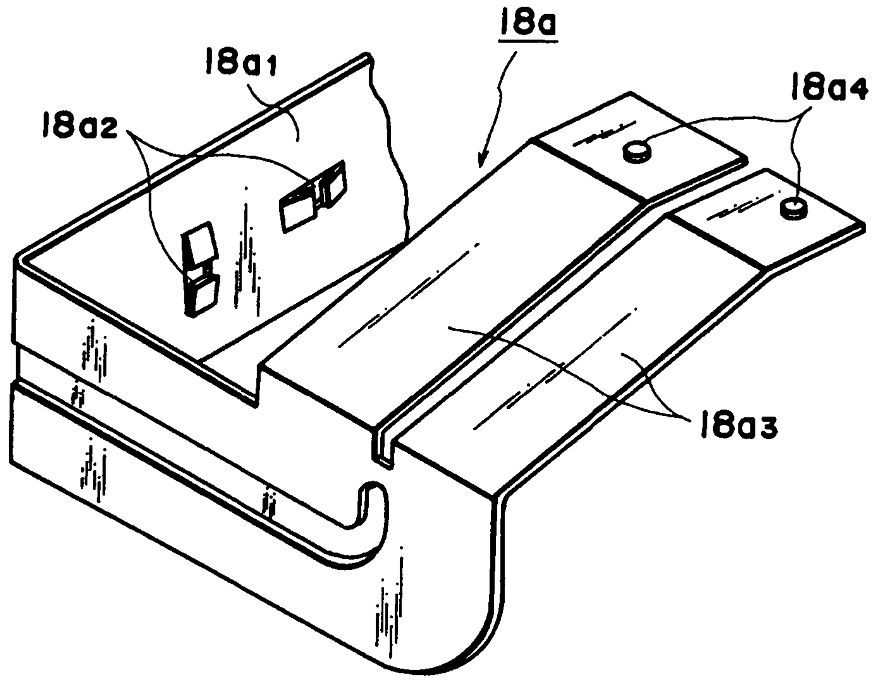


FIG. 11

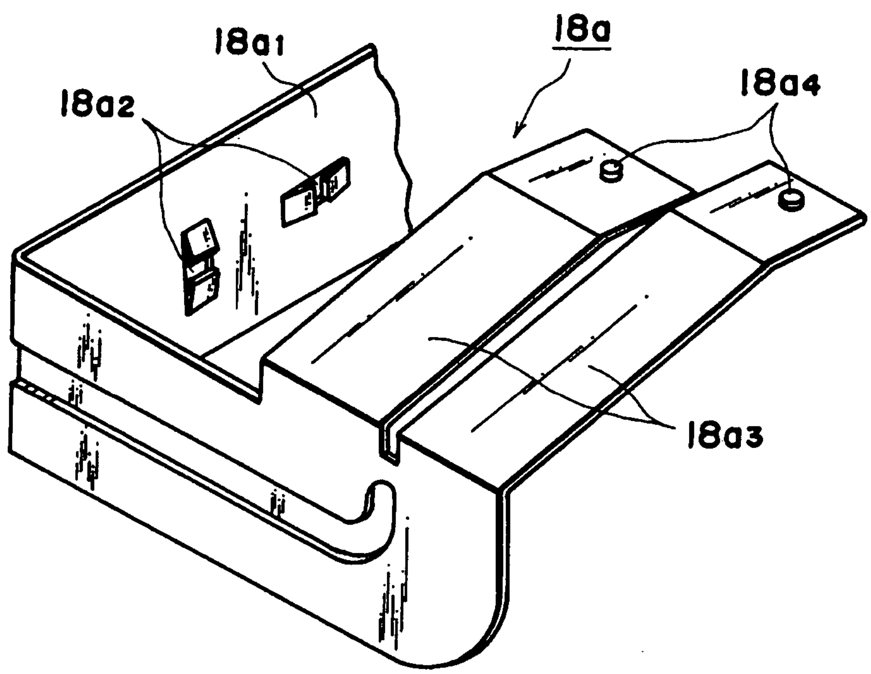


FIG. 12

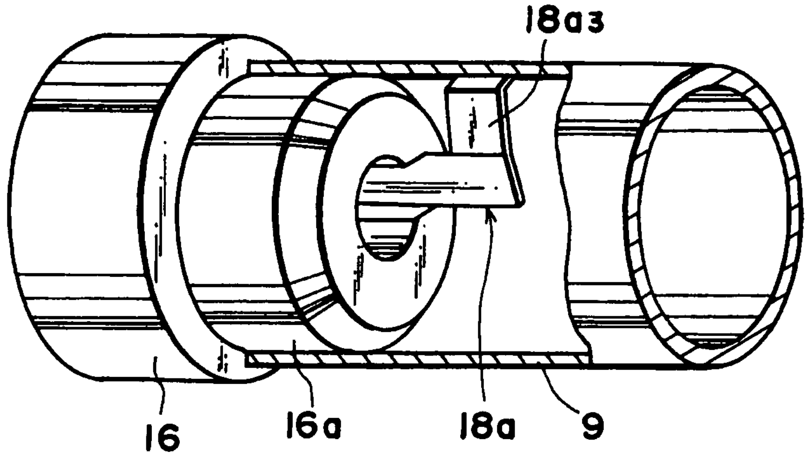


FIG. 13

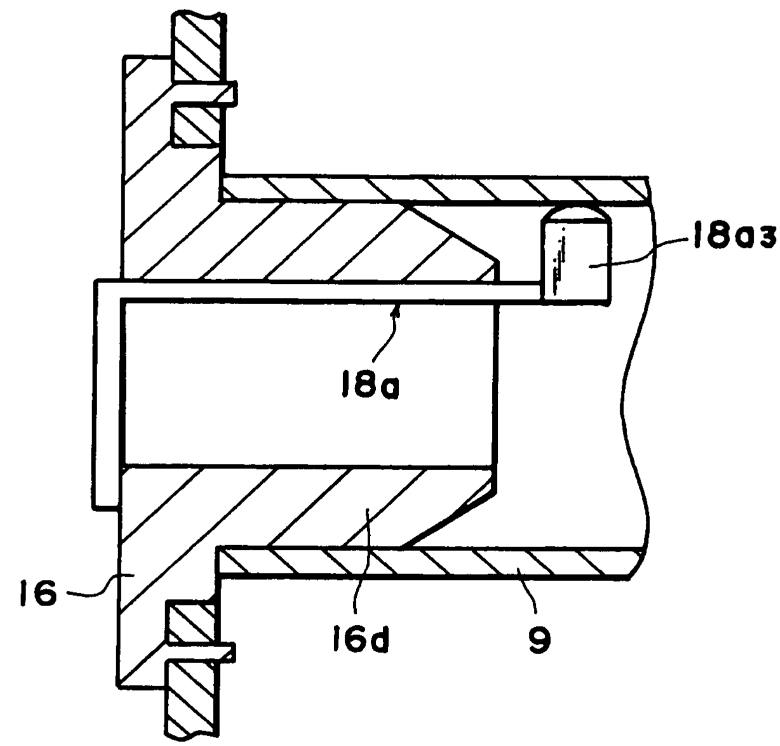


FIG. 14

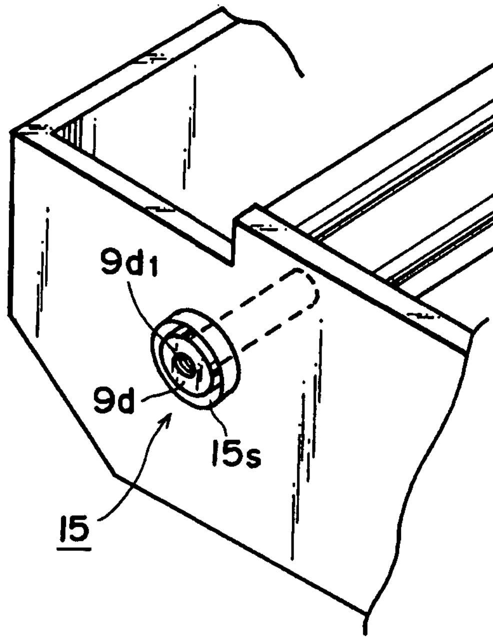

9d1
9d
15s
15

FIG. 15

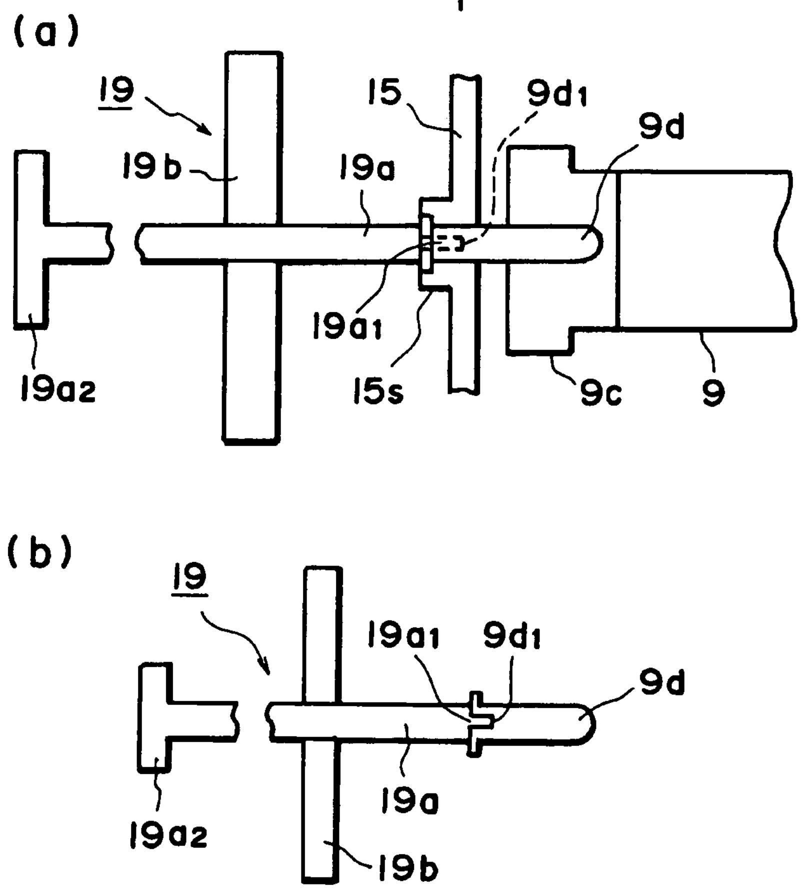

(a)
19
19b
19a
15
9d1
9d
19a1
15s
19a2
9c
9
(b)
19
19a1
9d1
9d
19a
19a2
19b

FIG. 16

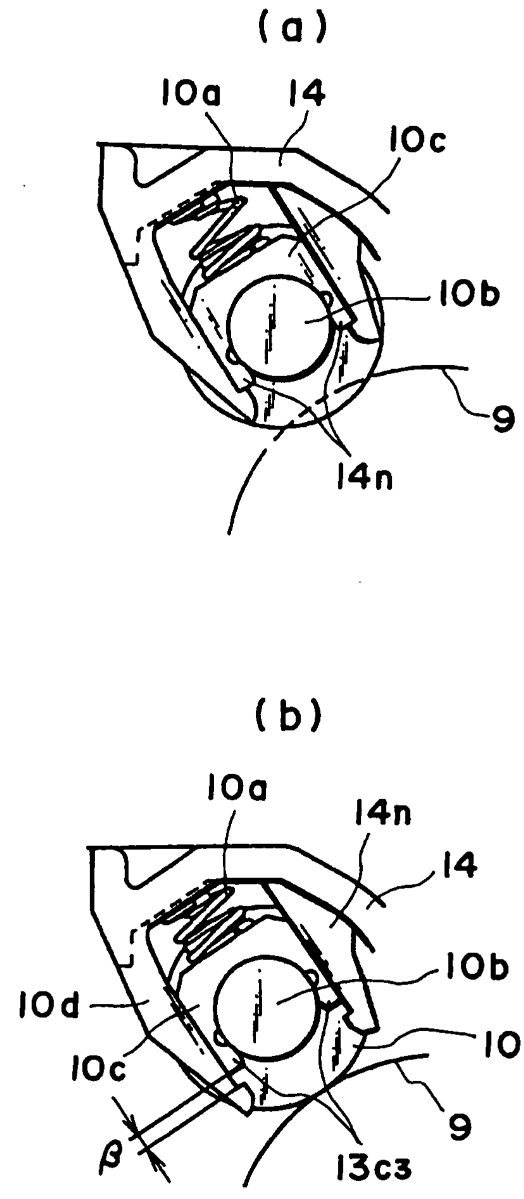


FIG. 17

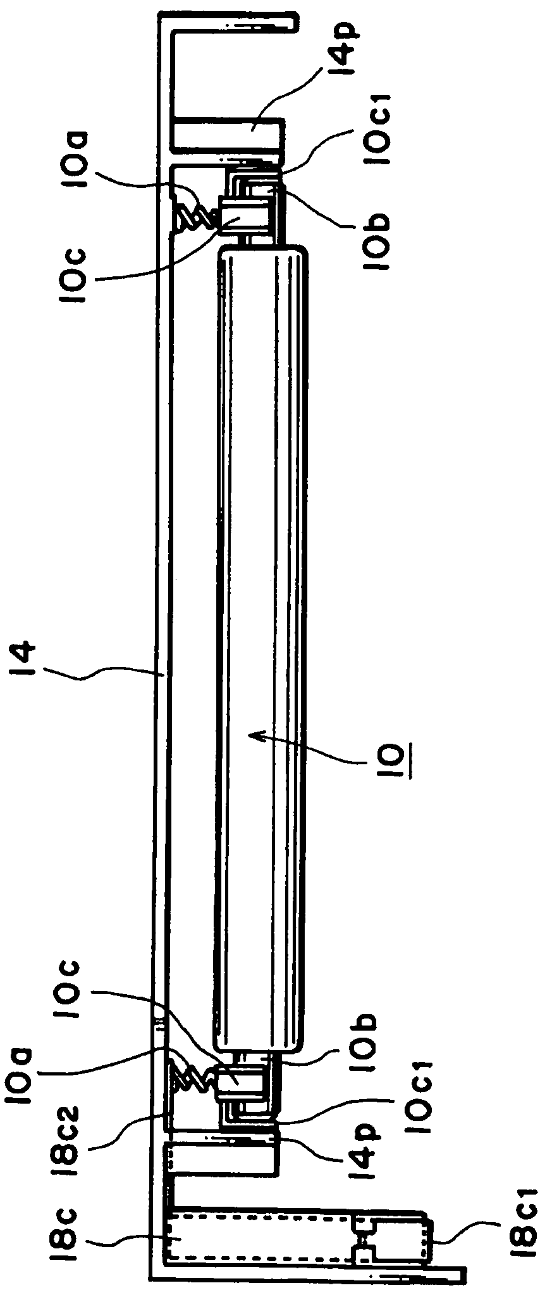


FIG. 18

(a)

(b)

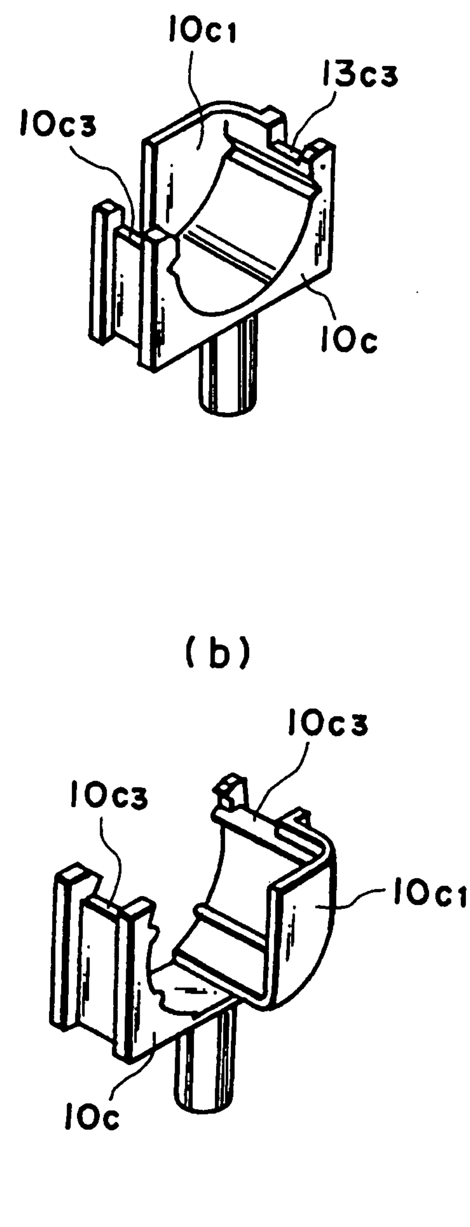


FIG. 19

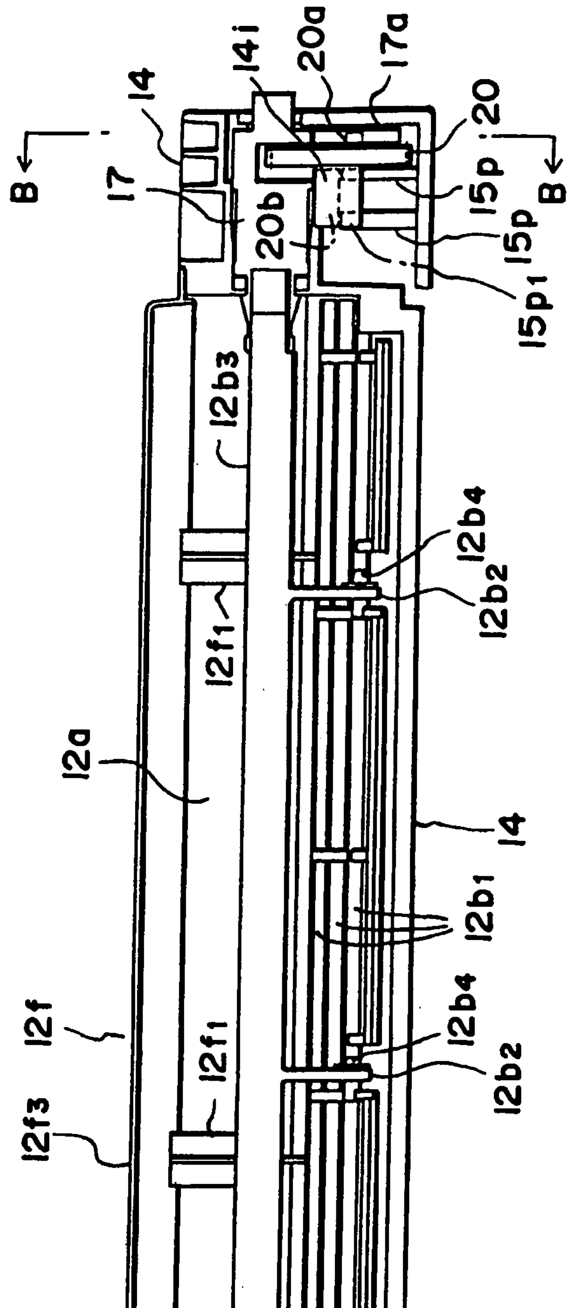

B
14
17
20b
14i
20a
17a
20
15p
15p
15p1
B
12b3
12b4
12b2
12f1
12a
14
12b1
12b4
12b2
12f
12f1
12f3
12f2
12a1

FIG. 20

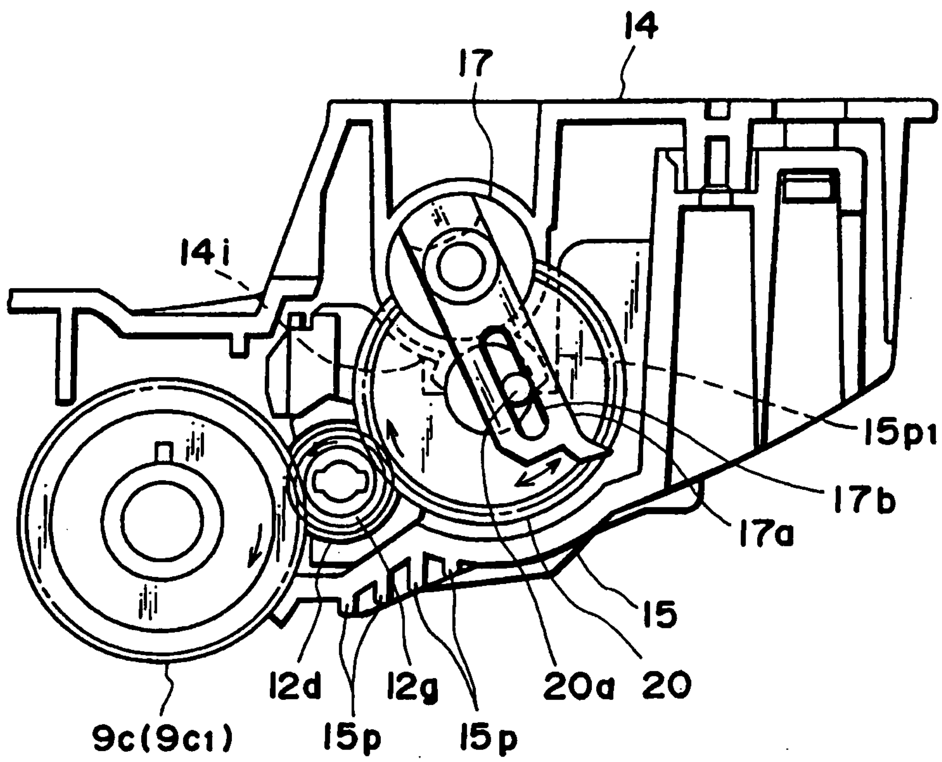


FIG. 21

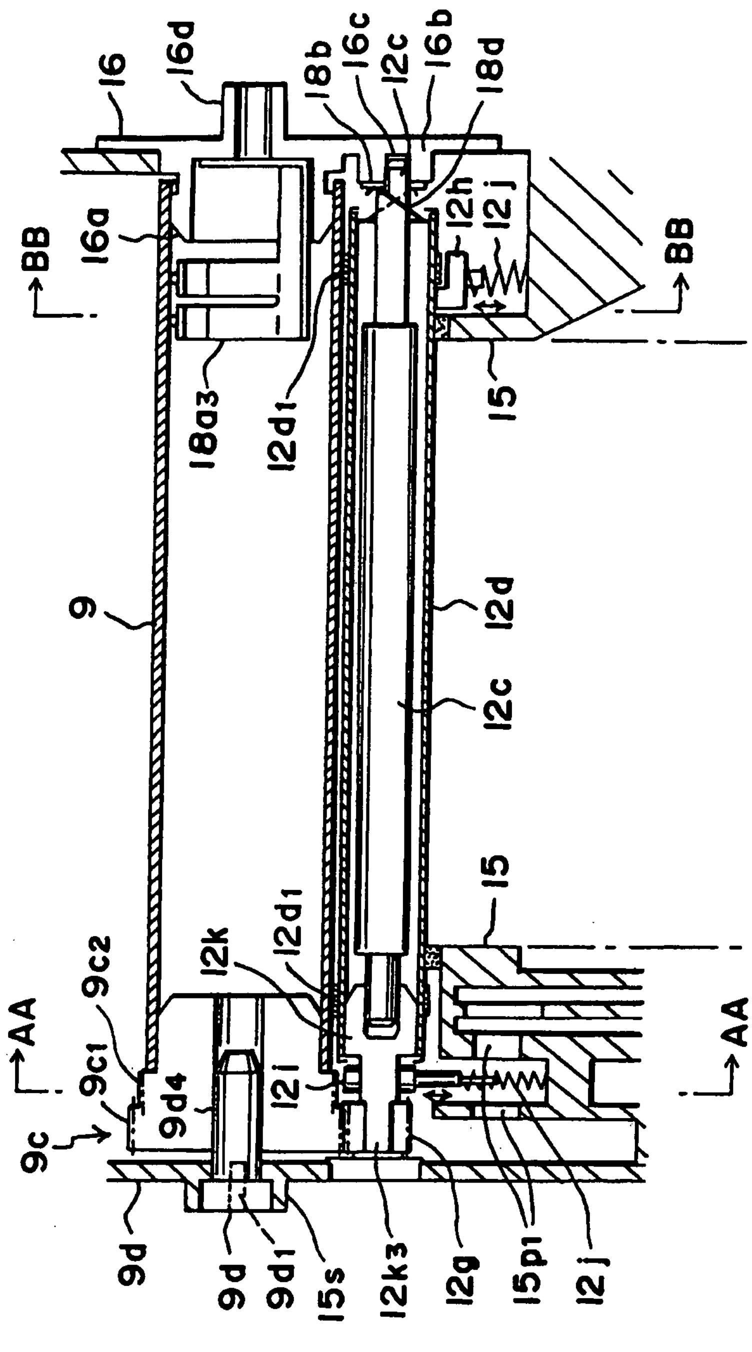

16
16d
18b
16c
12c
16b
18d
16a
12h
12j
BB
BB
18a3
12d1
15
9
12d
12c
15
9c2
AA
AA
9c1
9c
9d4
12k
12d1
12i
9d
9d
9d1
15s
12k3
12g
15p1
12j

FIG. 22

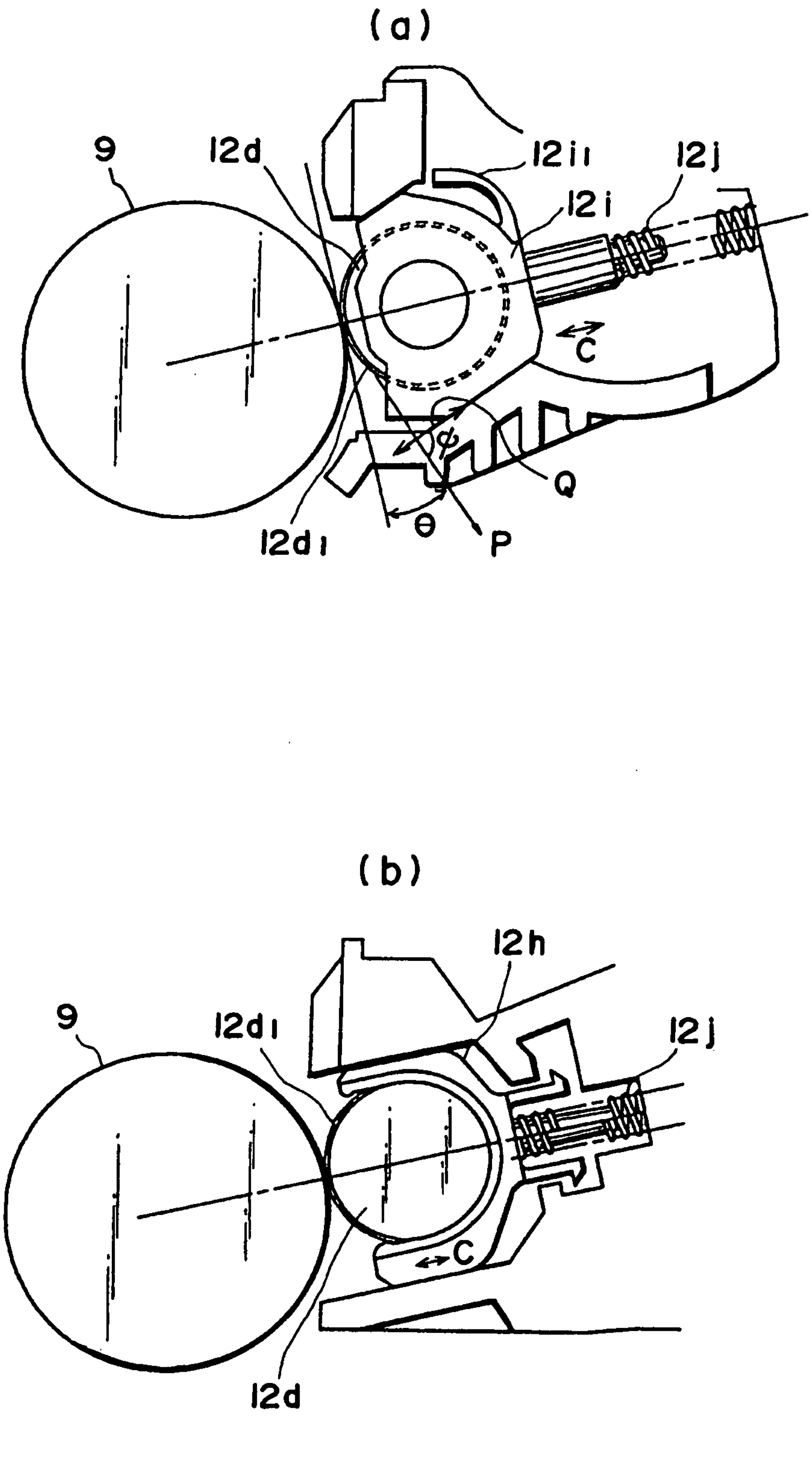


FIG. 23

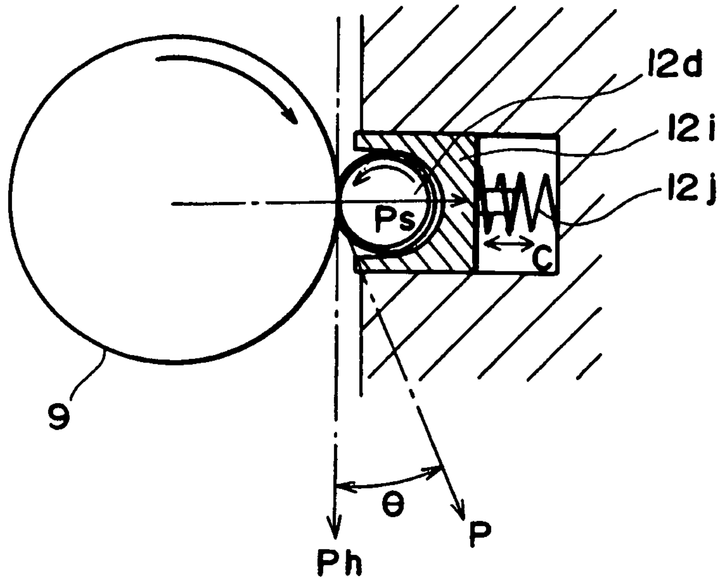

12d
12i
12j
Ps
C
9
θ
Ph
P

FIG. 24

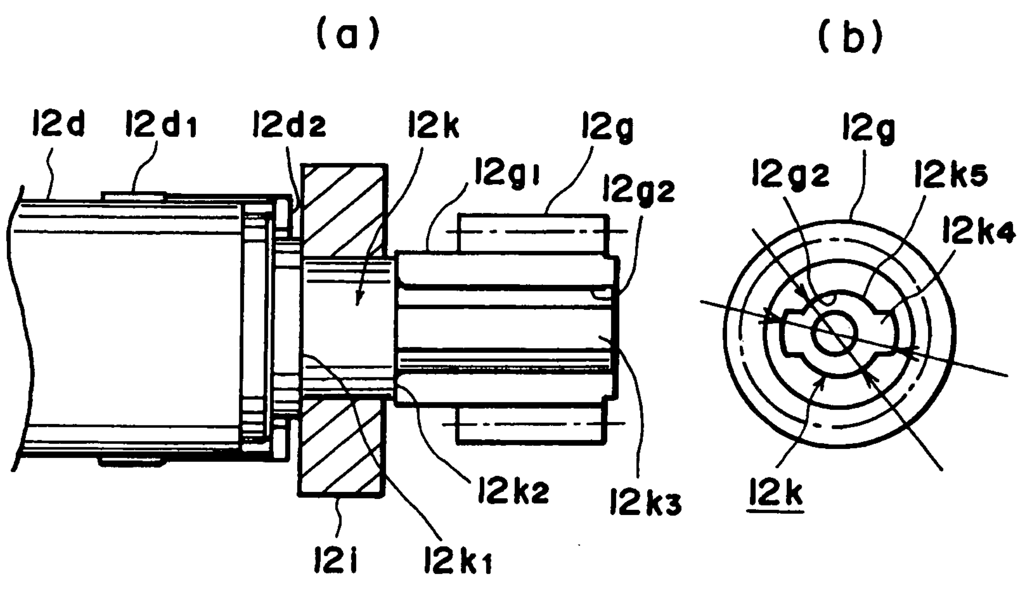

(a)
(b)
12d
12d1
12d2
12k
12g
12g1
12g2
12k2
12k3
12i
12k1
12g
12g2
12k5
12k4
12k

FIG. 25

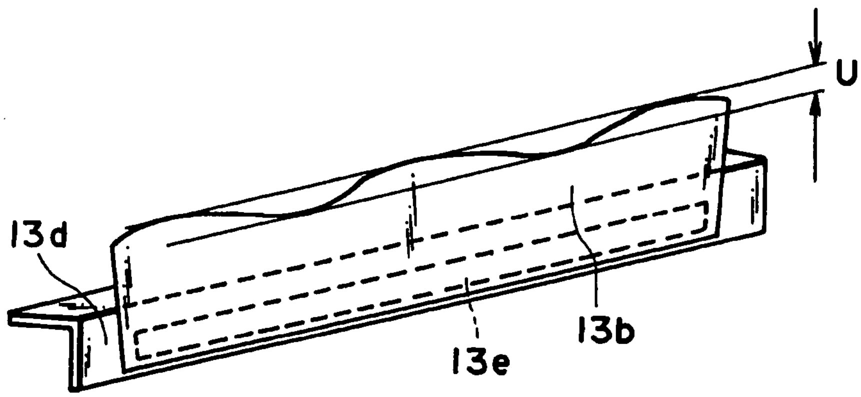

U
13d
13b
13e

FIG. 26

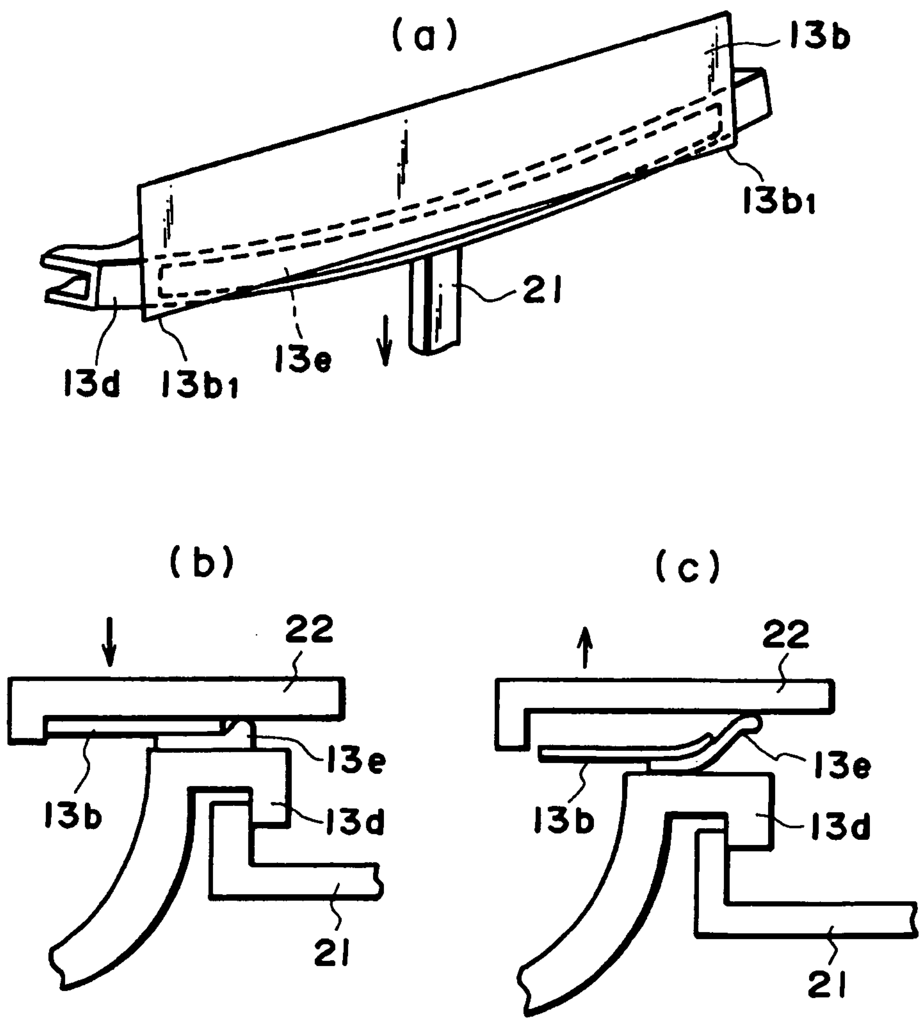

(a)
13b
13b1
21
13d
13b1
13e
(b)
22
13e
13b
13d
21
(c)
22
13e
13b
13d
21

FIG. 27

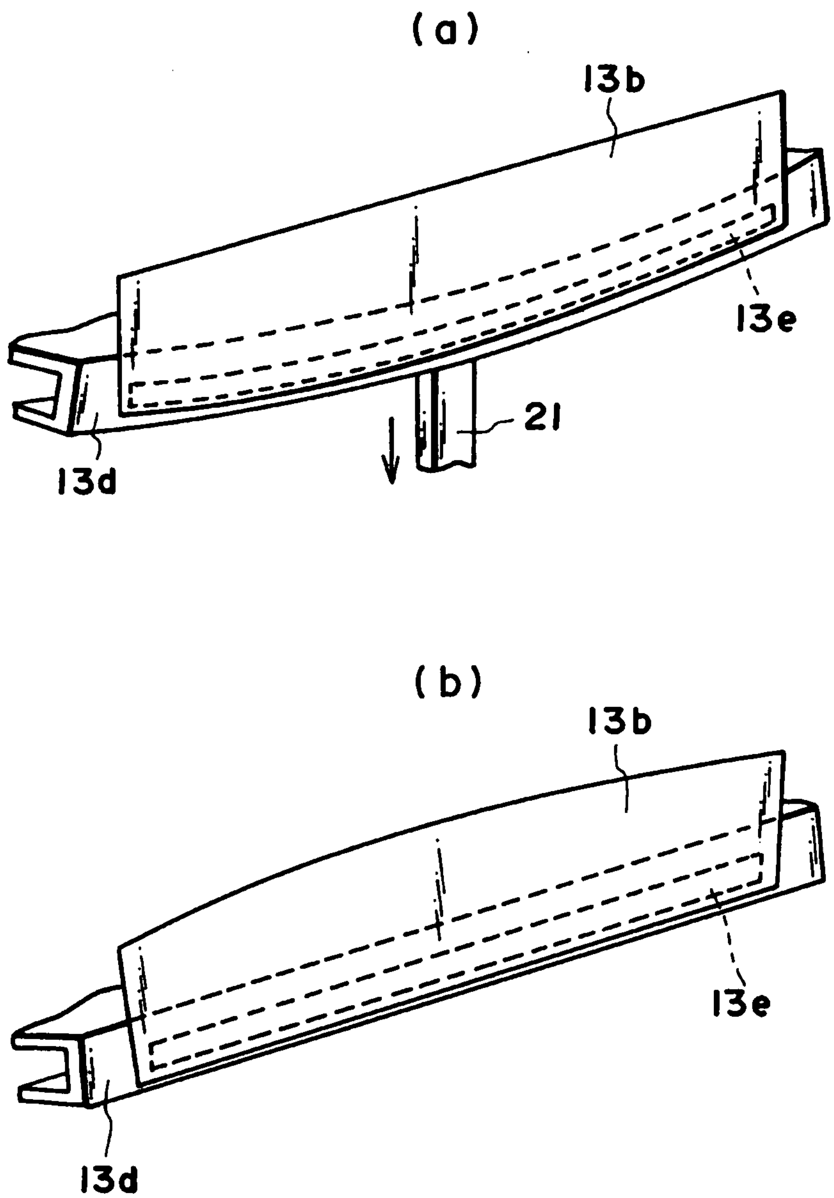


FIG. 28

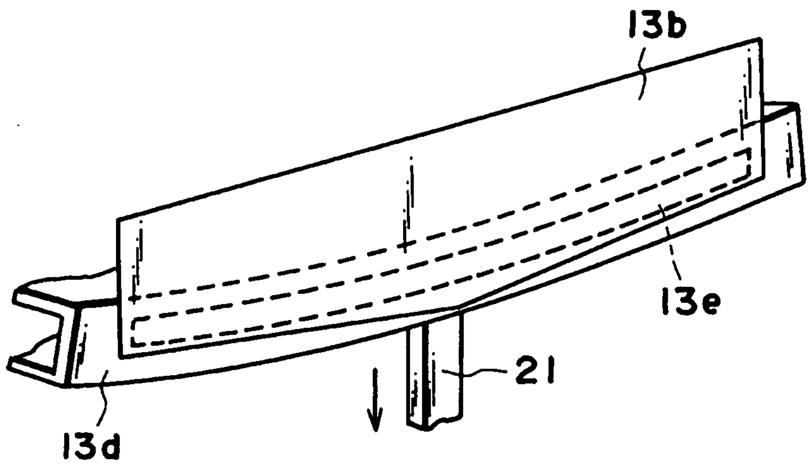


FIG. 29

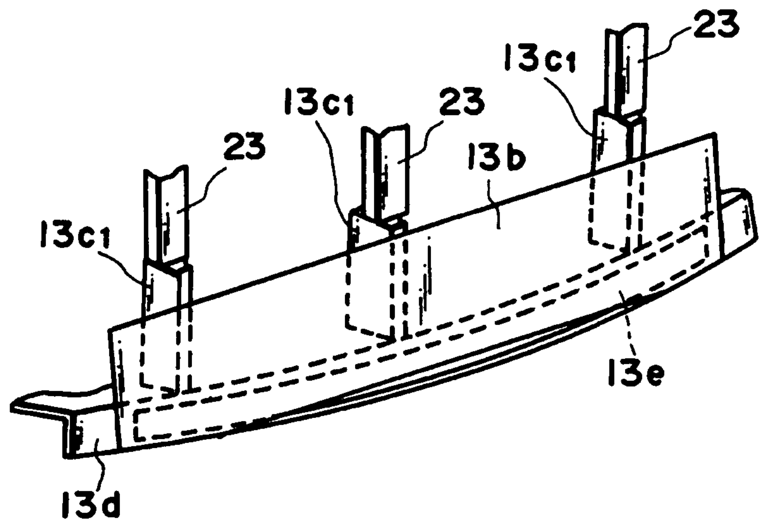


FIG. 30

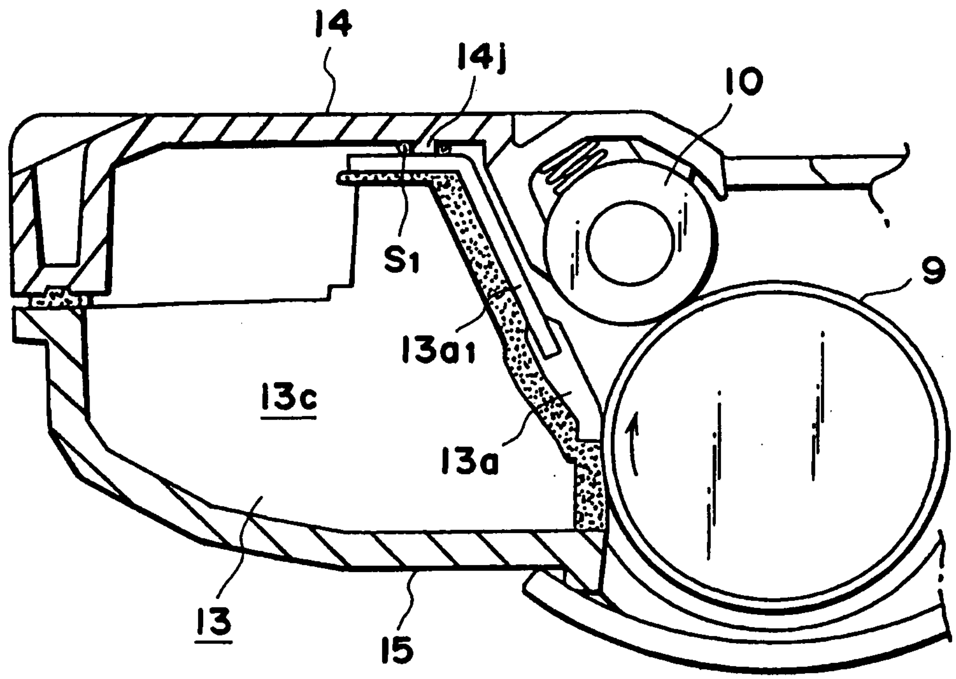
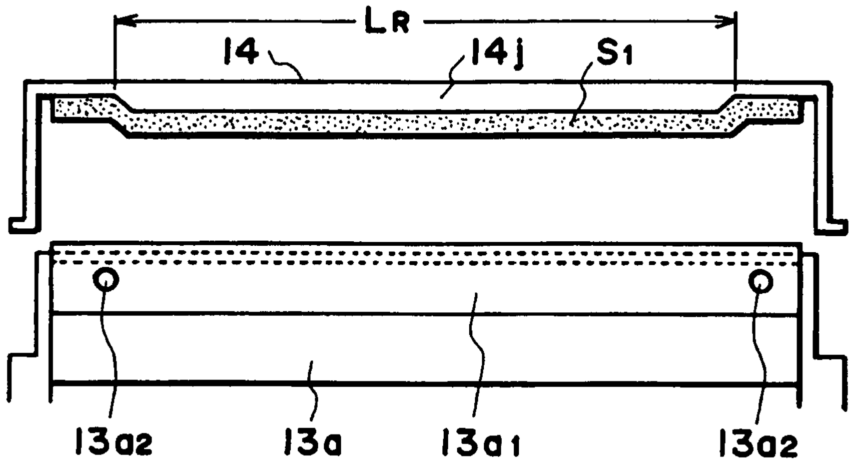


FIG. 31

(a)



(b)

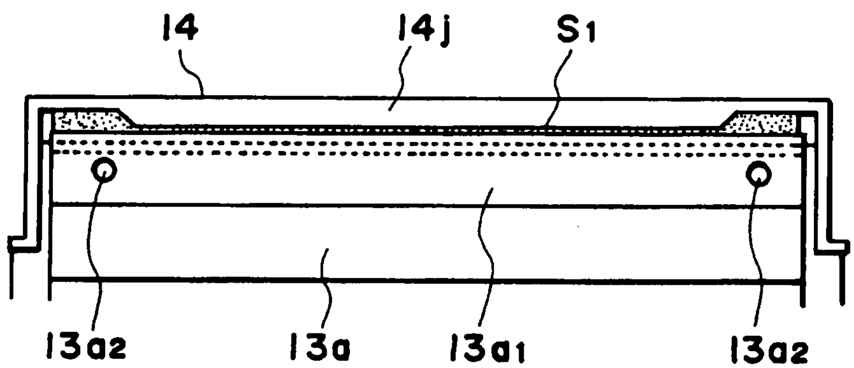


FIG. 32

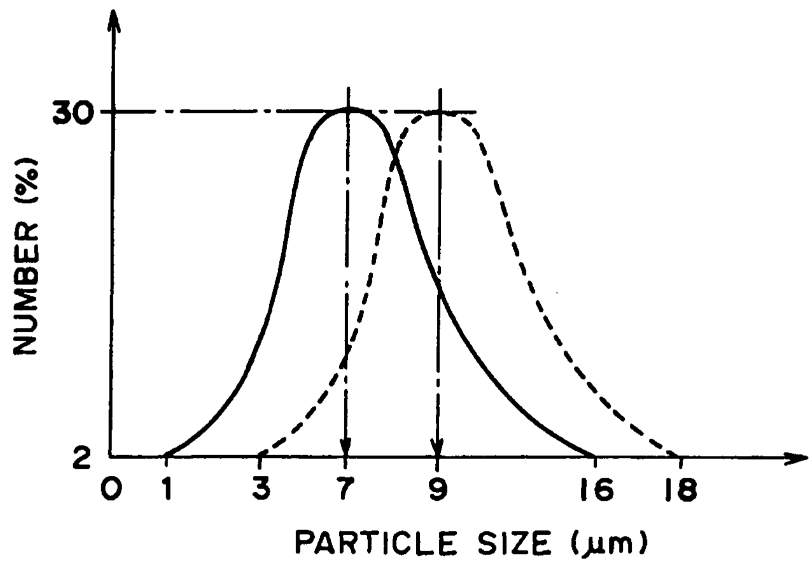


FIG. 33

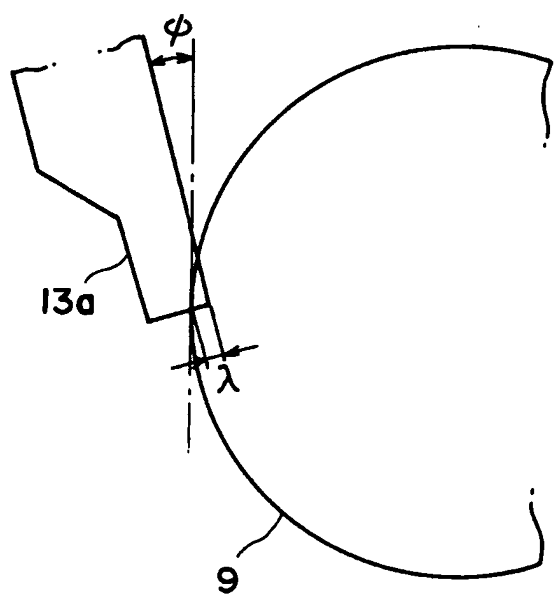


FIG. 34

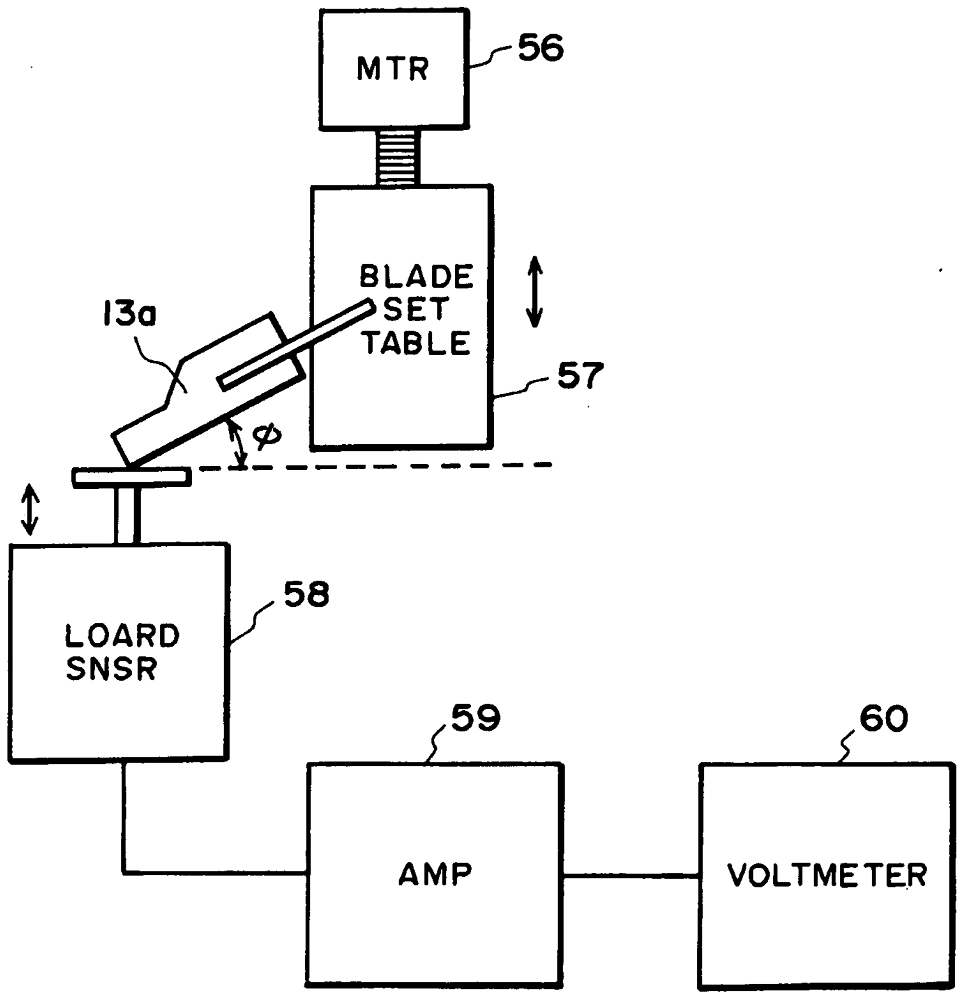

MTR
56
BLADE SET TABLE
57
13a
φ
LOARD SNSR
58
59
60
AMP
VOLTMETER

FIG. 35

TEST Nos.	BLADE CONTACT PRESSURE (gf/cm)	AVE. PARTICLE SIZE (μm)	CLEANABILITY	CHARGEABILITY	DRUM STATE
1	15	9	○	○	○
2	15	7	×	×	○
3	20	7	△	△	○
4	20	4	△	△	○
5	25	7	○	○	○
6	25	5	○	○	○
7	25	4	○	○	○
8	60	7	○	○	△
9	60	4	○	○	△
10	65	7	○	○	×
11	65	4	○	○	×

FIG. 36

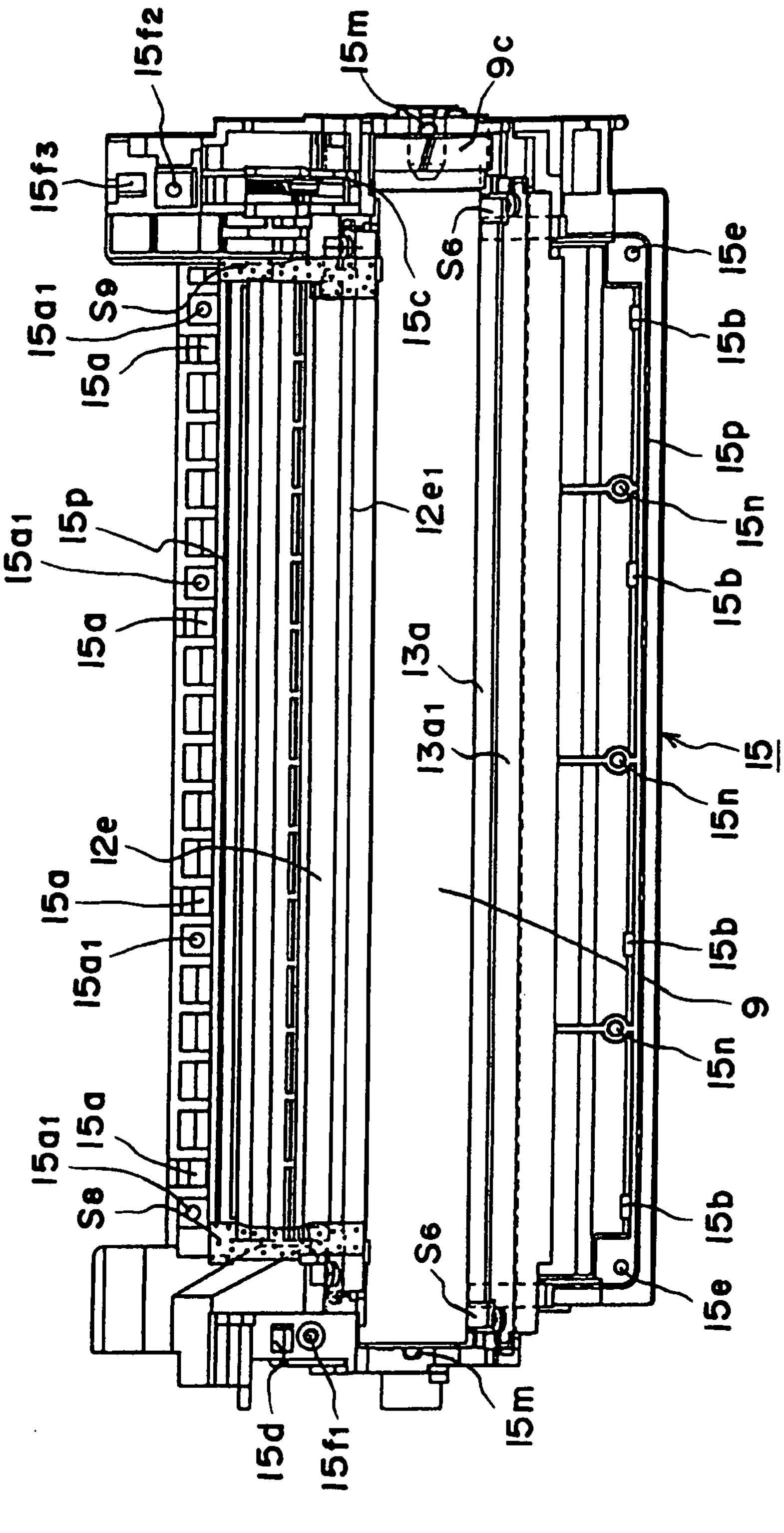

15f3
15f2
15m
9c
15a1
S9
15a
15c
S6
15e
15b
15p
15a1
12e1
15n
15b
15a
13a
13a1
15
12e
15a
15a1
9
15n
15b
15a1
15a
S8
S6
15b
15e
15d
15f1
15m

FIG. 37

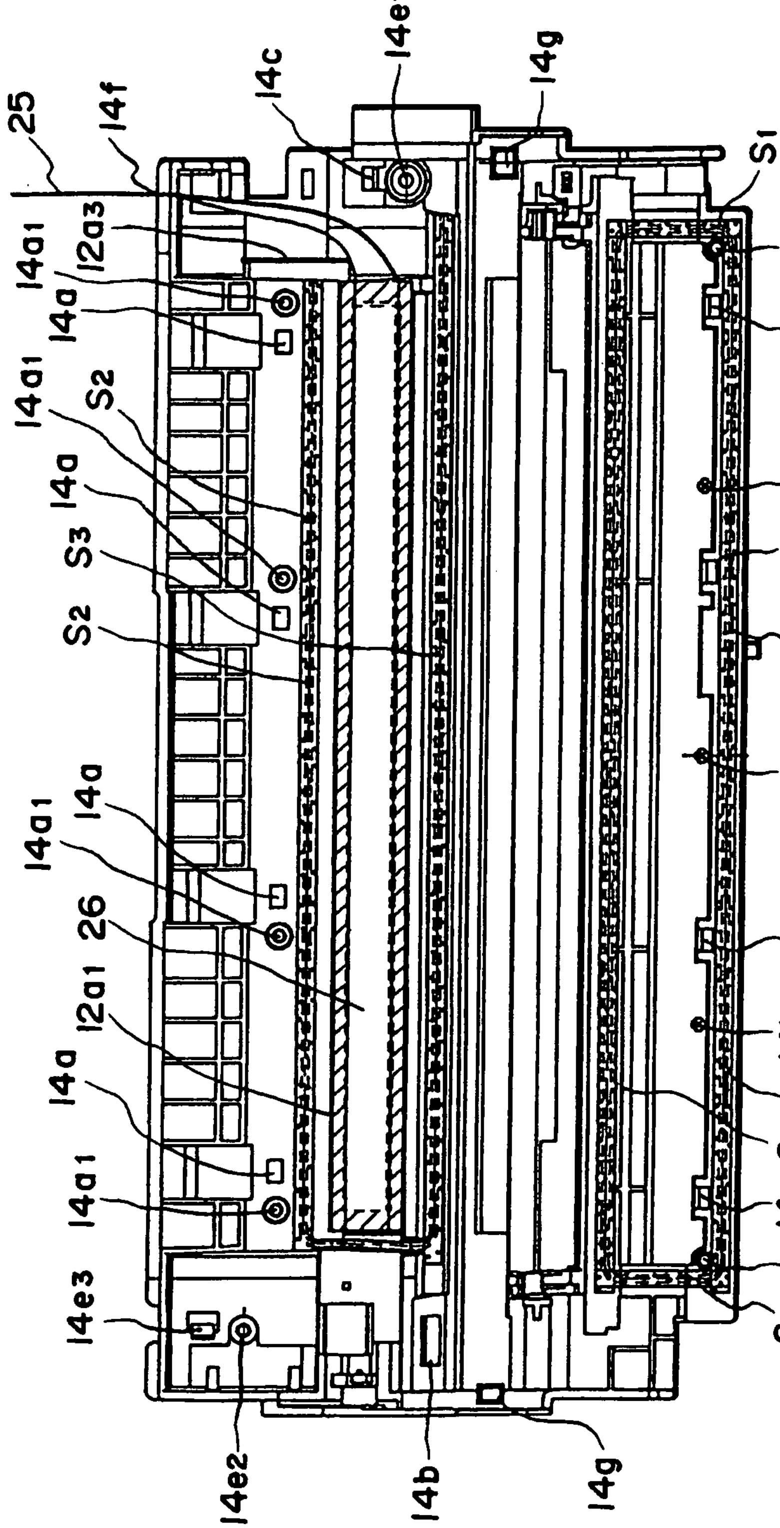

25
14f
12a3
14a1
14a
S2
S3
26
12a1
14e3
14e2
14b
14g
14c
14e1
14d
14h
S1

FIG. 38

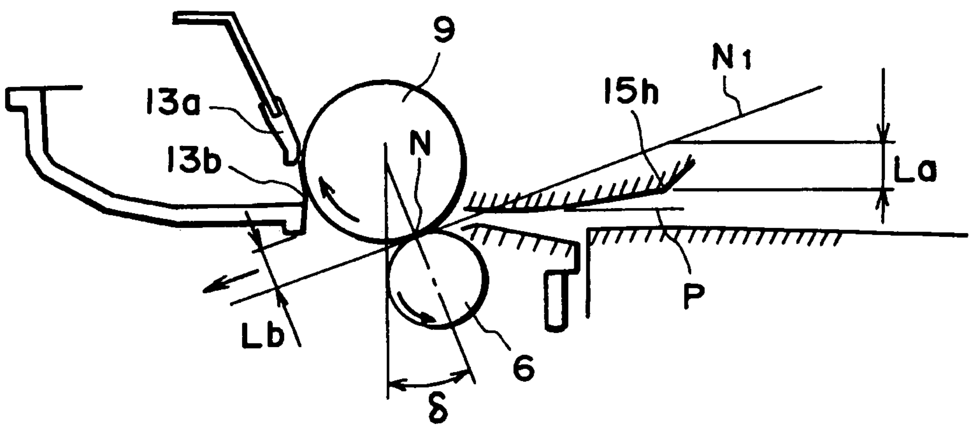


FIG. 39

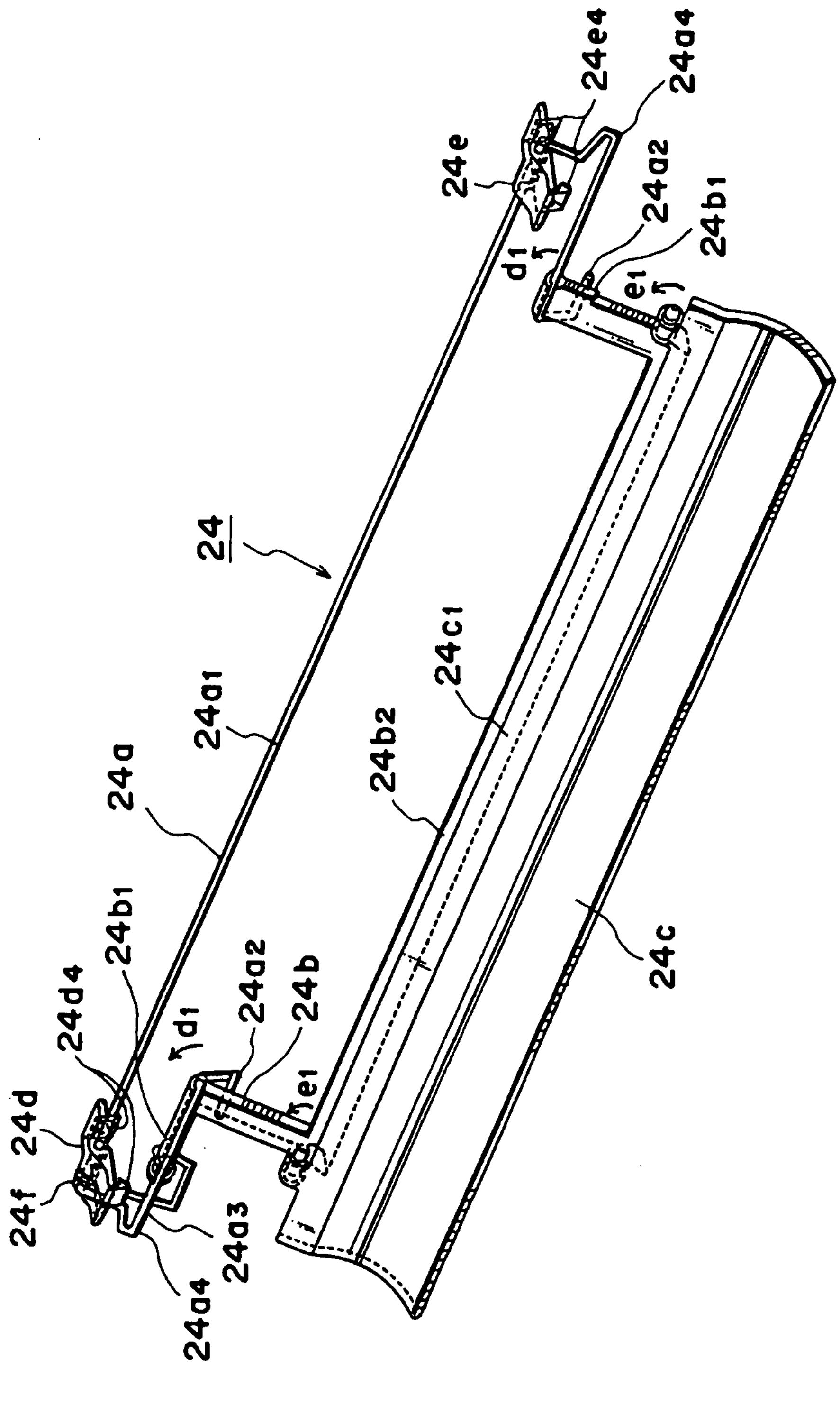

24
24a
24a1
24b2
24c1
24c
24e
24e4
24a4
24a2
24b1
d1
e1
24d
24f
24d4
24b1
24a2
24b
d1
e1
24a3
24a4

FIG. 40

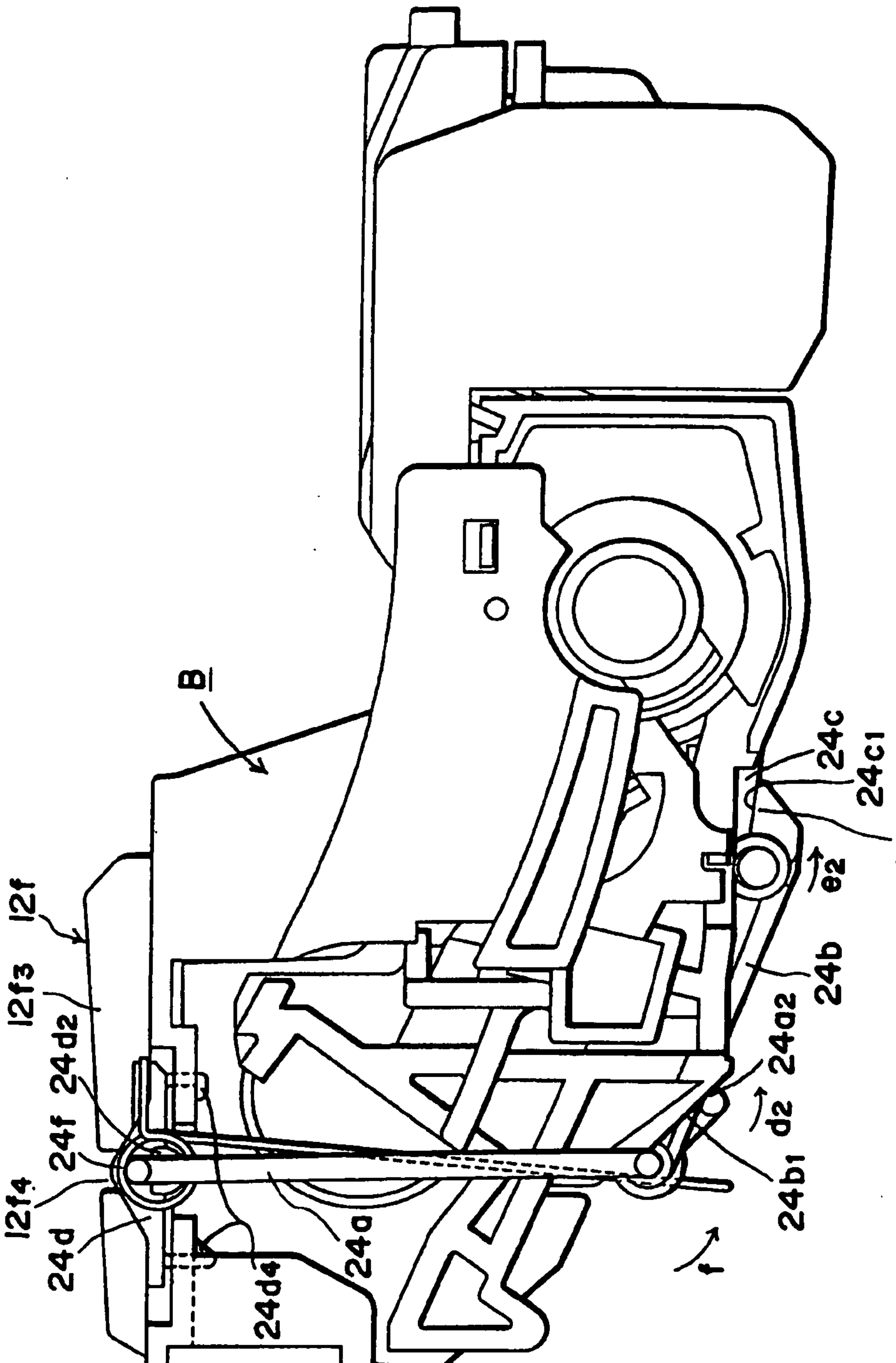

B
12f
12f3
12f4
24d2
24f
24d
24d4
24a
24a2
24b1
d2
24b
θ2
24b2
24c1
24c

FIG. 41

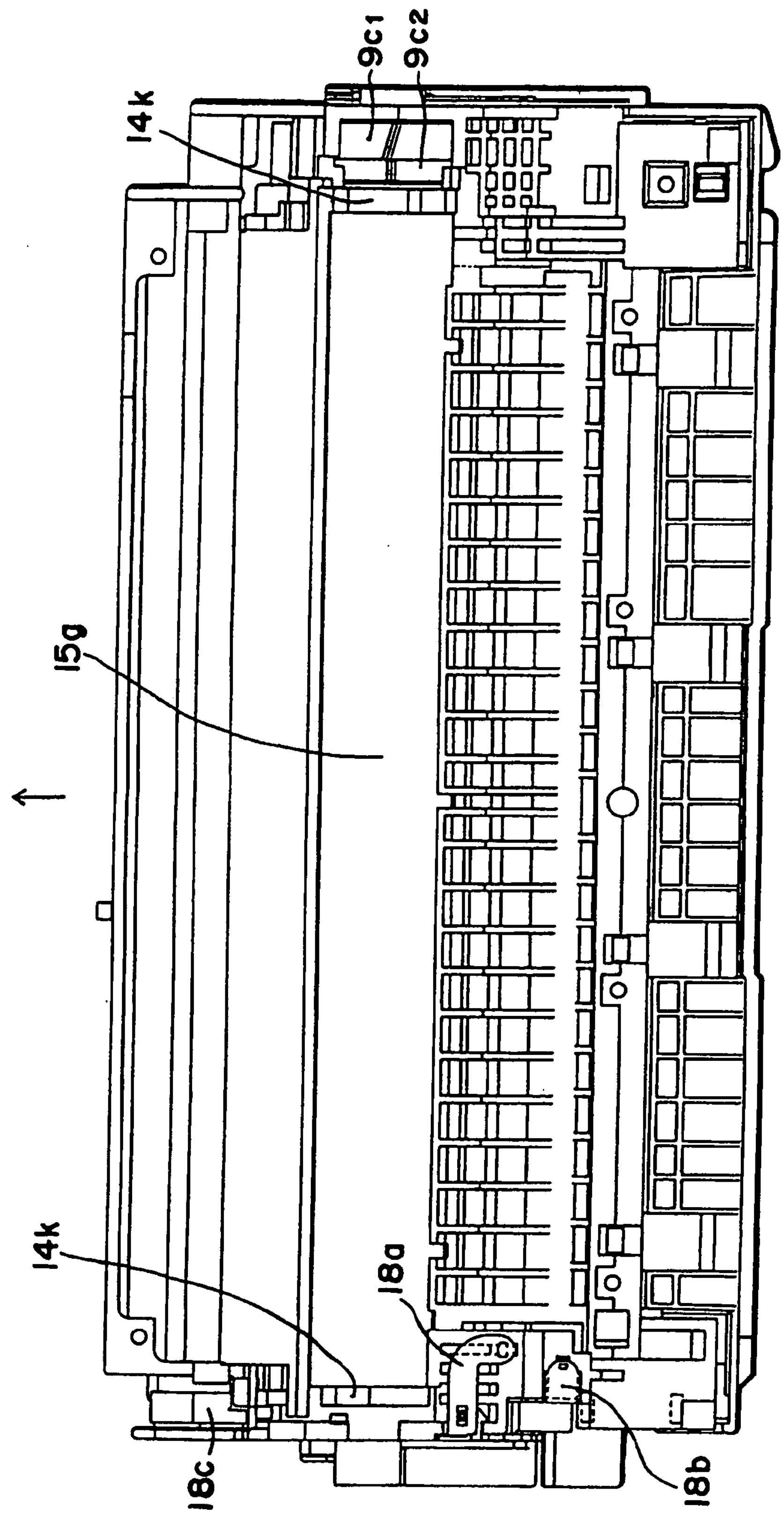


FIG. 42

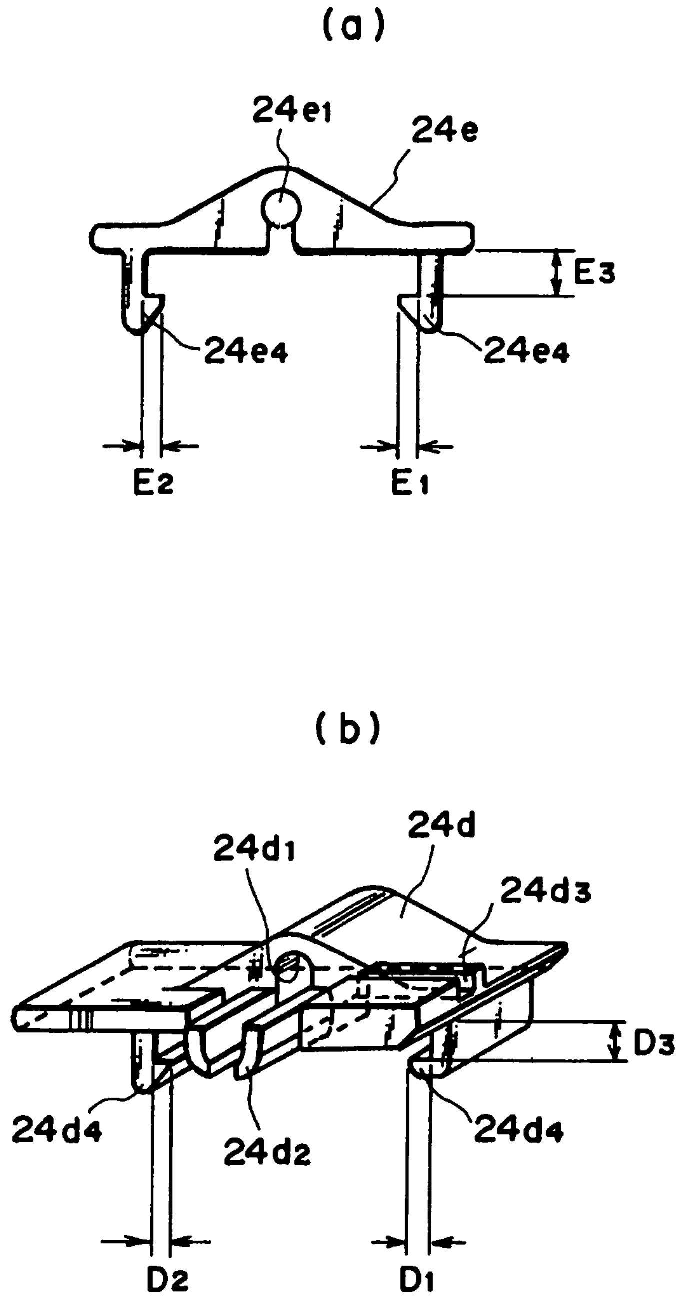

(a)
24e1
24e
E3
24e4
24e4
E2
E1
(b)
24d
24d1
24d3
D3
24d4
24d2
24d4
D2
D1

FIG. 43

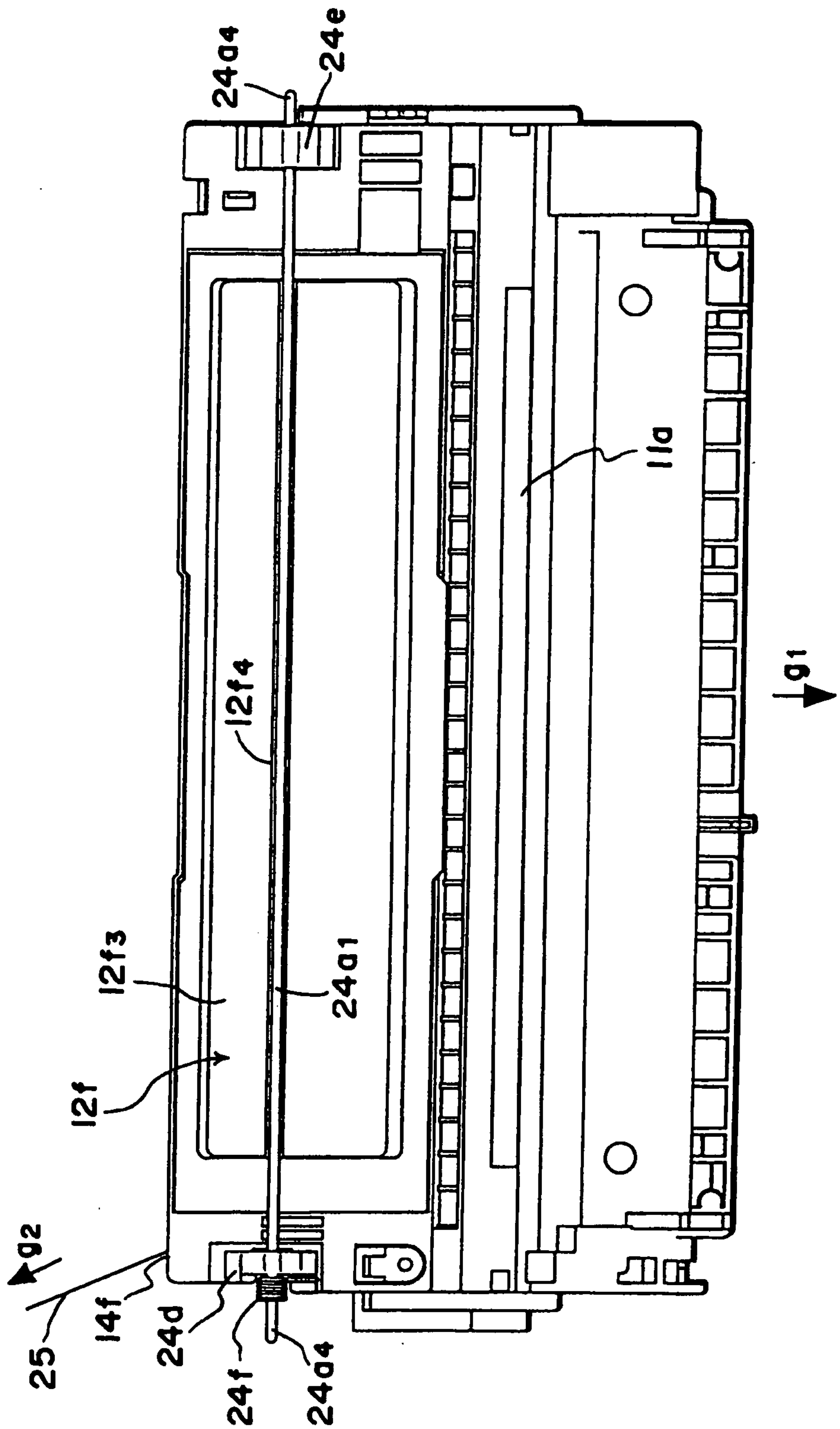
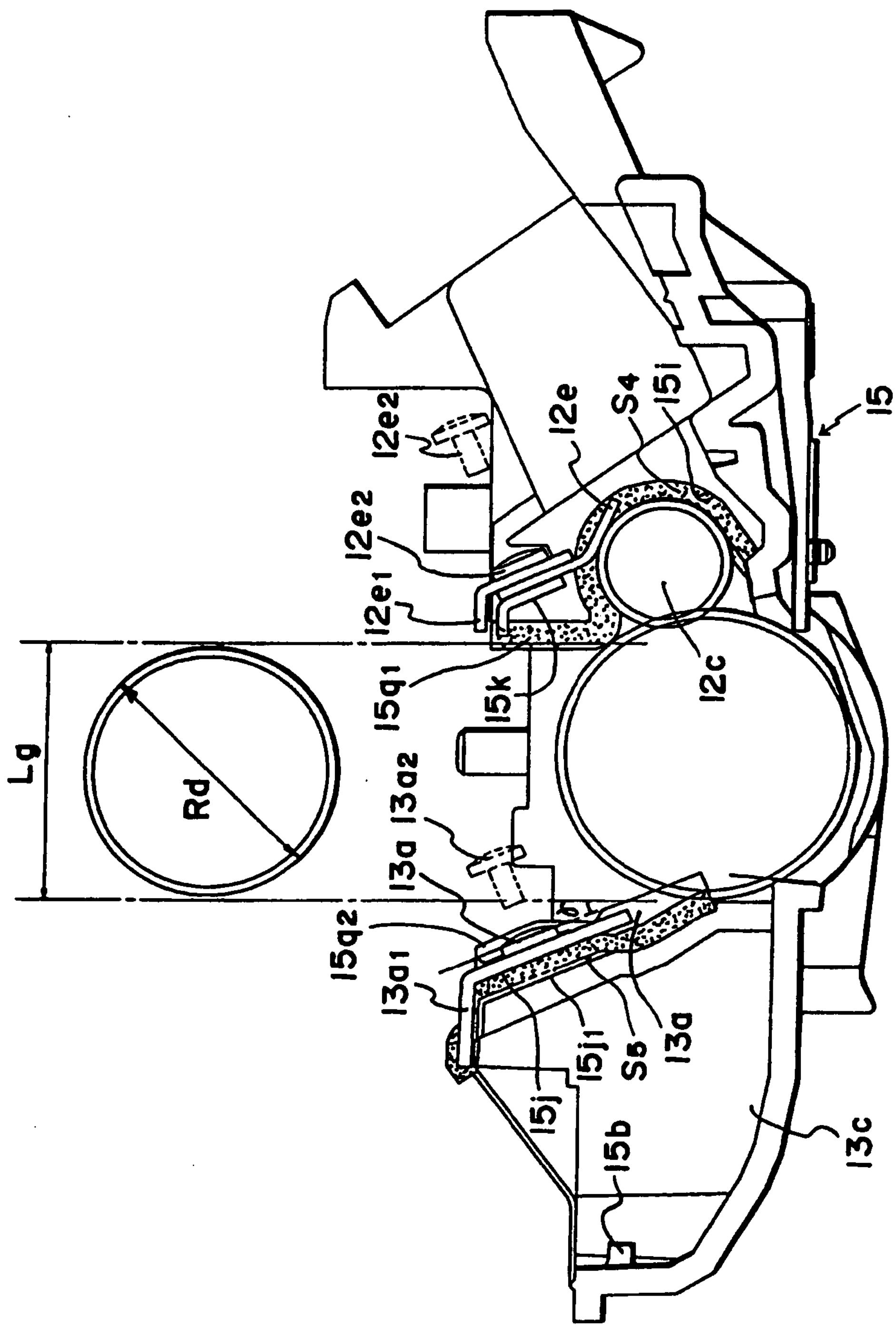


FIG. 44



Lg
Rd
12e2
12e2
12e1
15q1
15k
12e
S4
15i
15
12c
13a2
13a
15q2
13a1
15j
15j1
S5
13a
13c
15b

FIG. 45

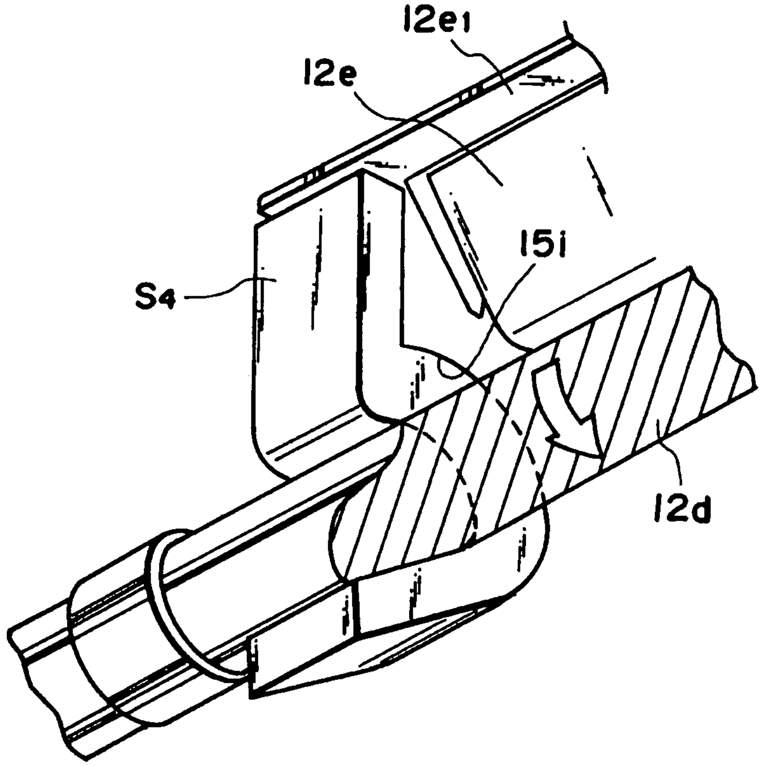


FIG. 46

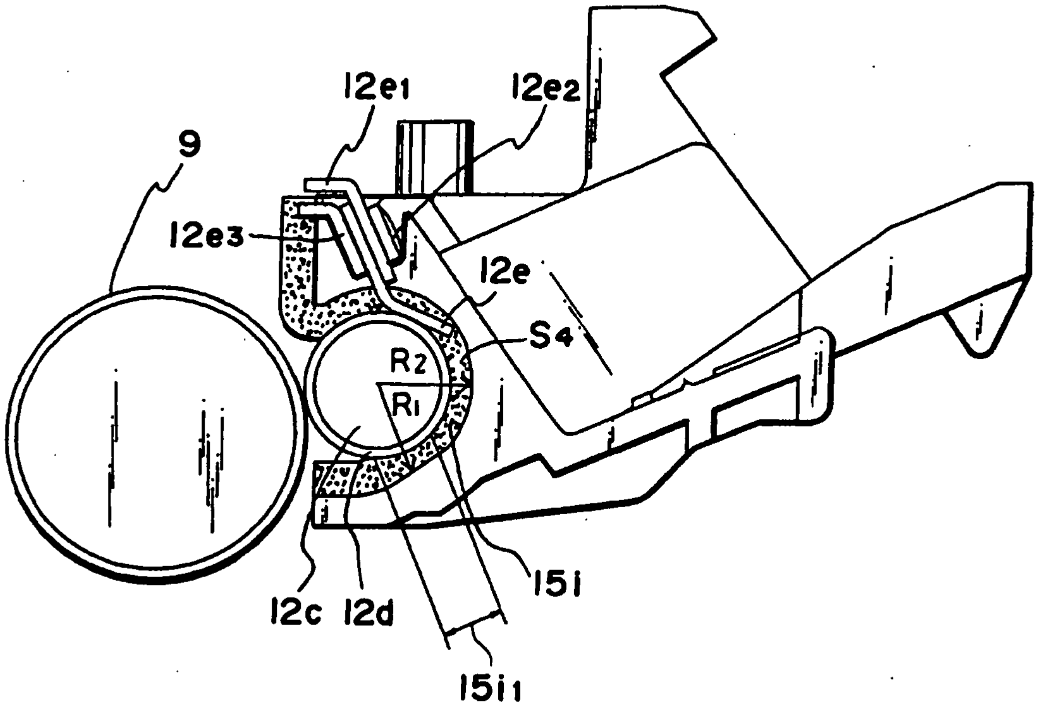


FIG. 47

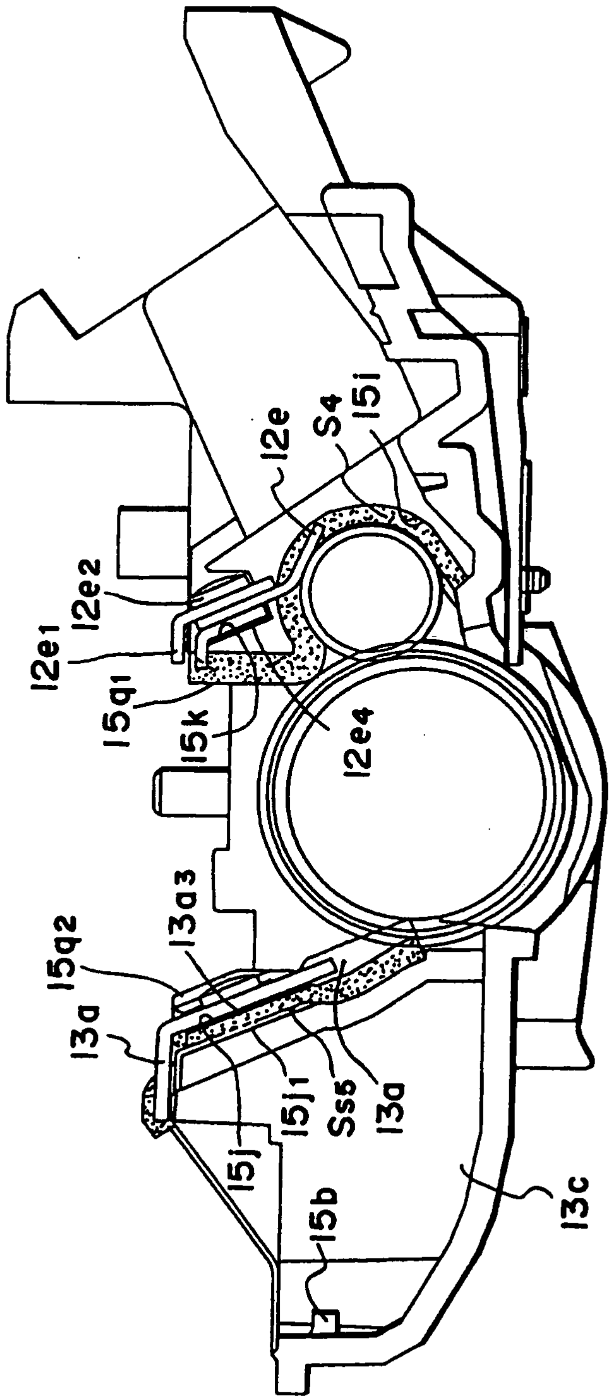

12e
S4
15l
12e2
12e1
15q1
15k
12e4
13a3
15q2
13a
15j1
Ss5
13a
15j
15b
13c

FIG. 48

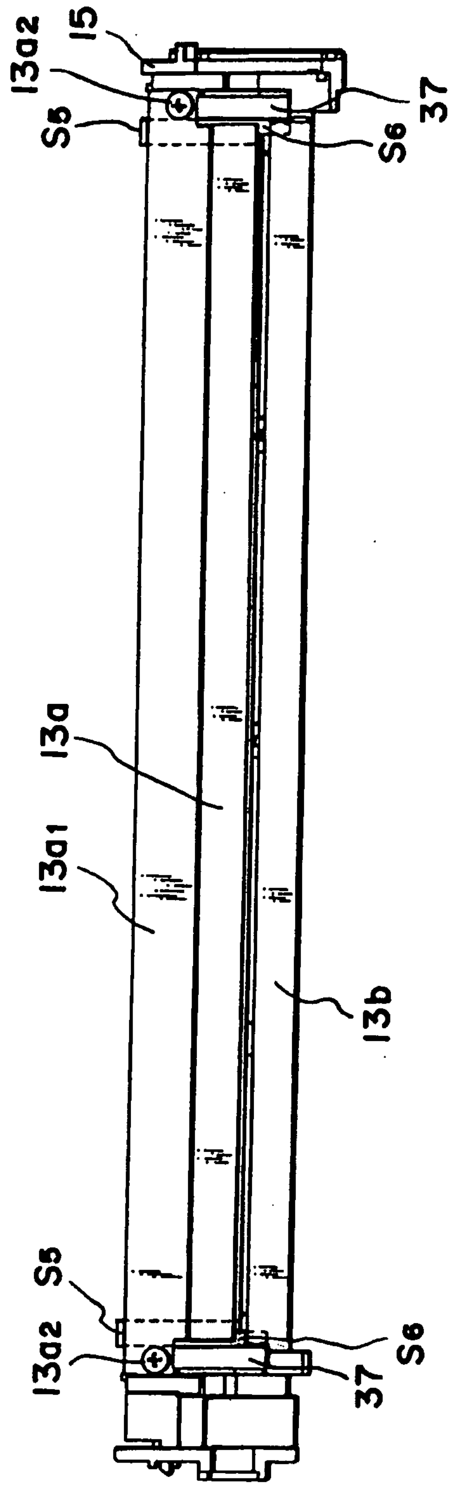


FIG. 49

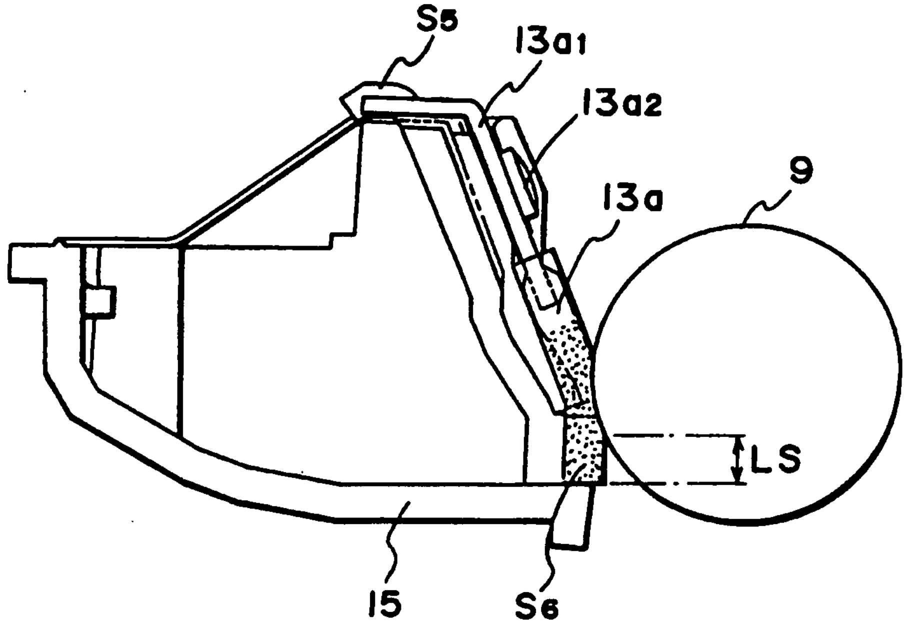


FIG. 50

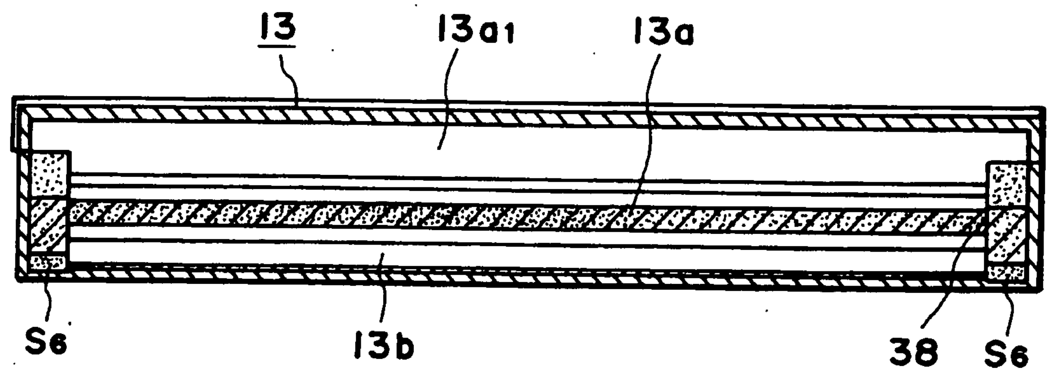


FIG. 51

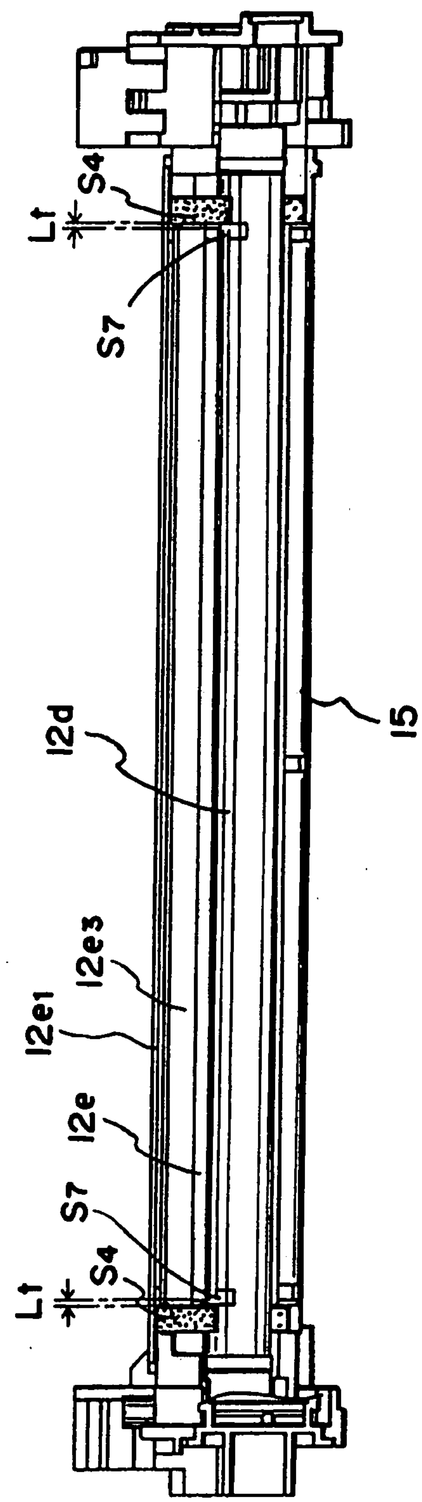


FIG. 52

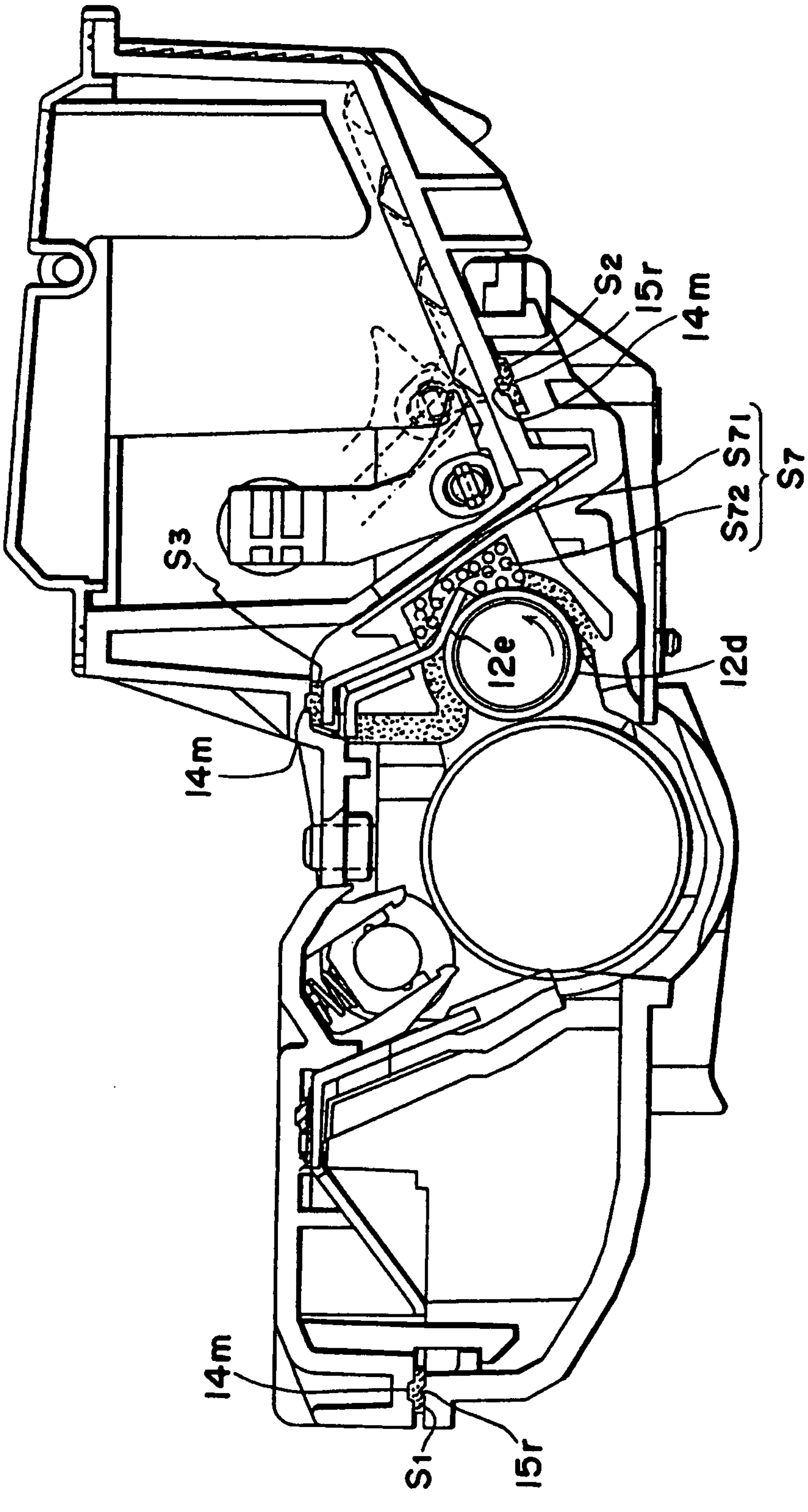


FIG. 53

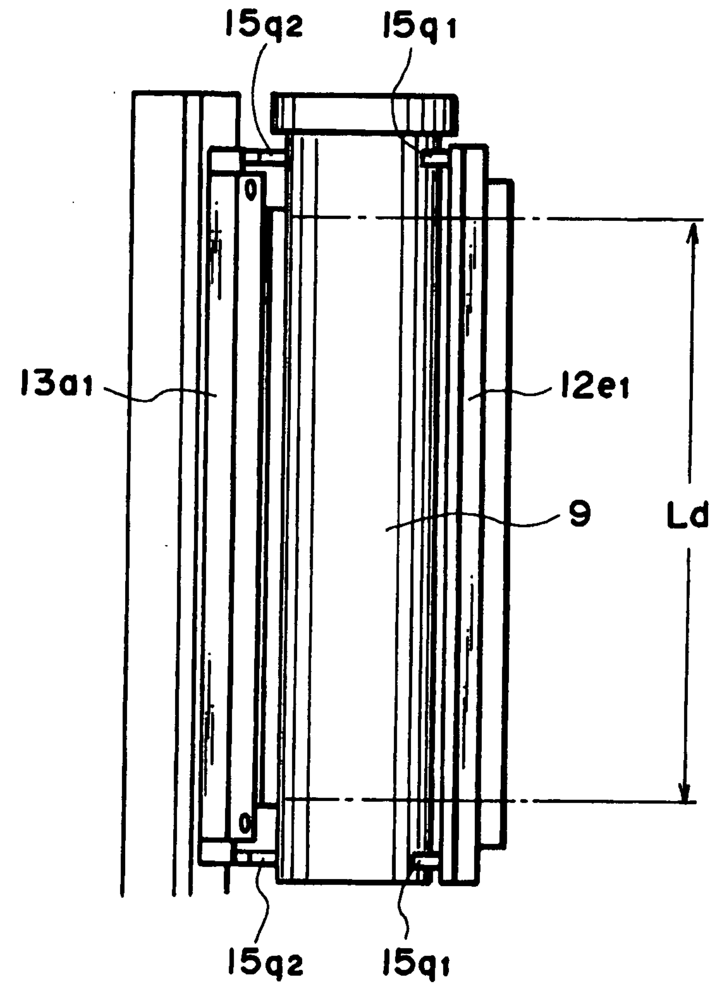


FIG. 54

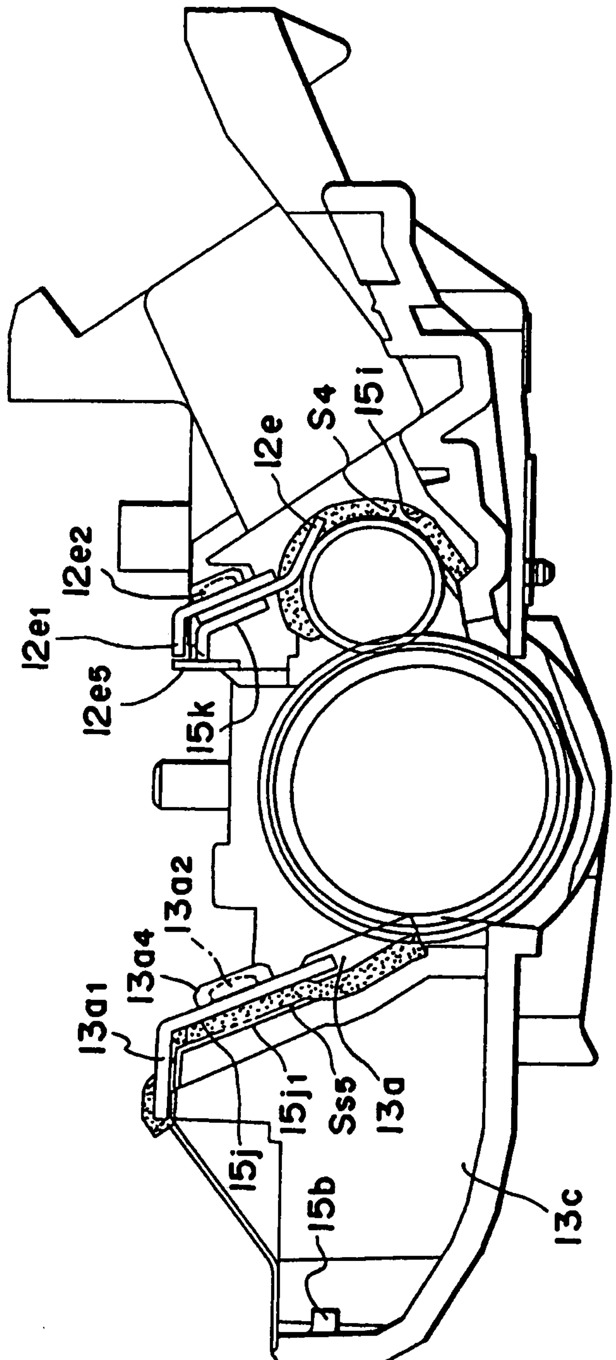
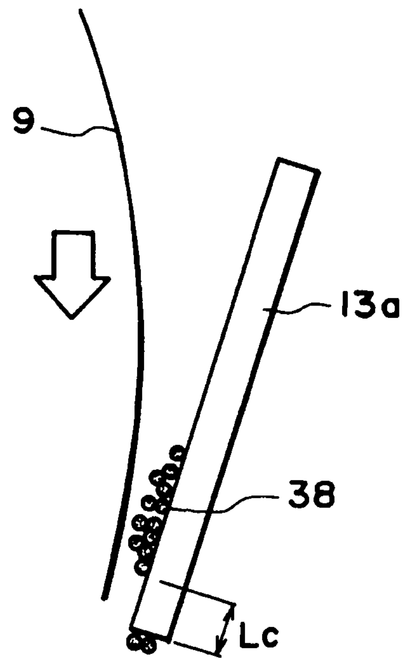

12e
S4
15i
12e2
12e1
12e5
15k
13a2
13a4
13a1
15j
15j1
Ss5
13a
15b
13c

FIG. 55

(a)



(b)

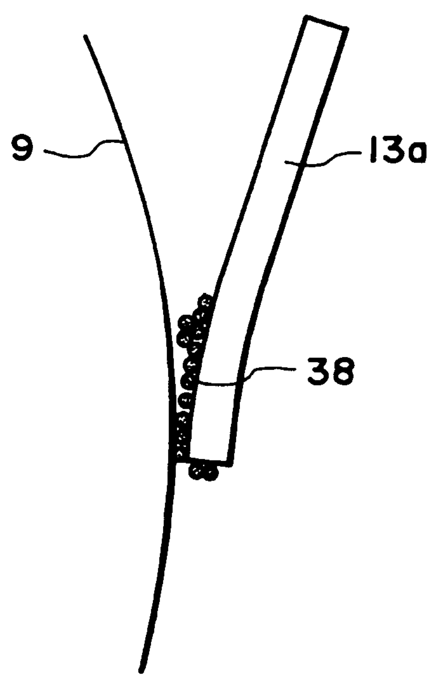


FIG. 56

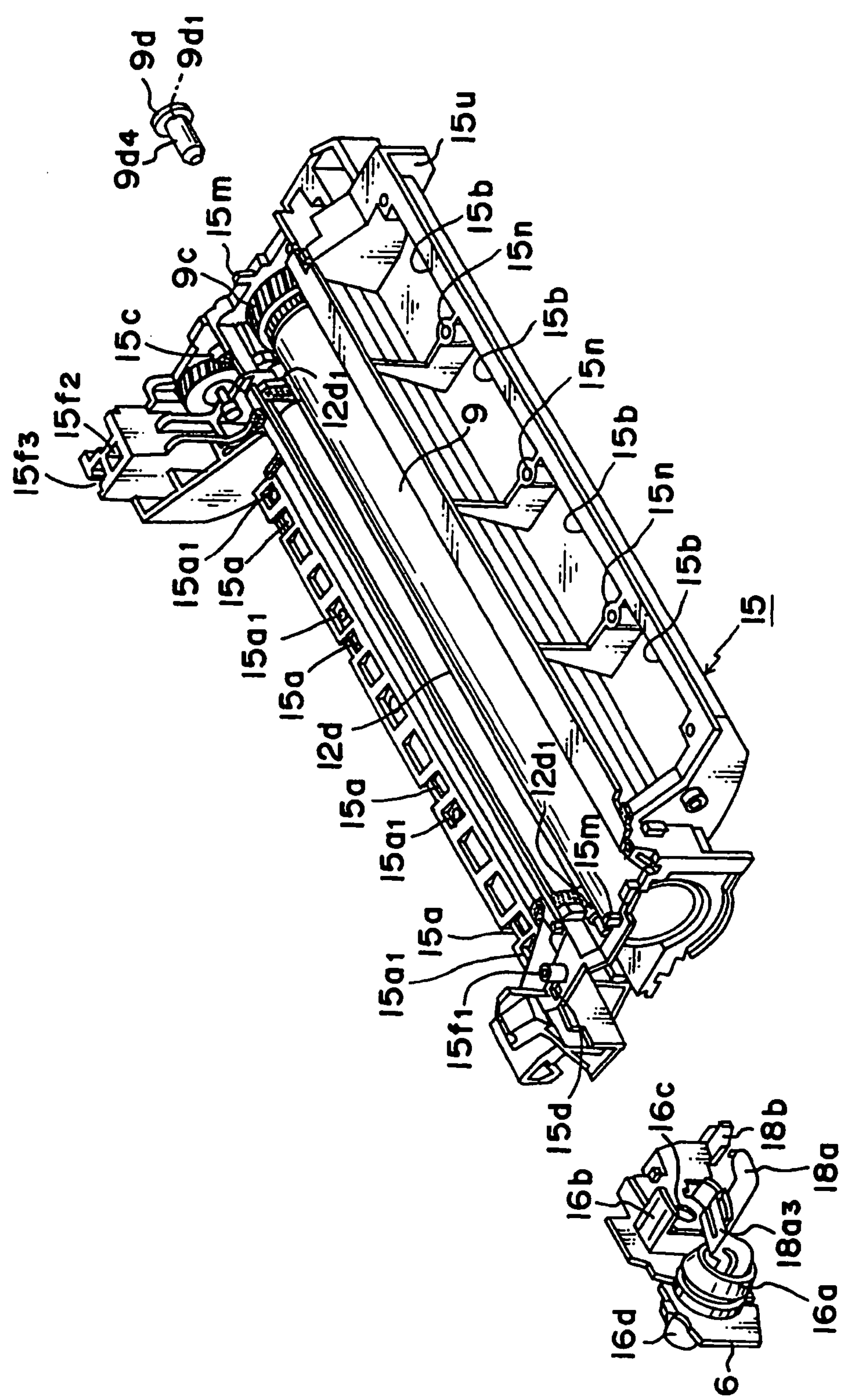

9d
9d1
9d4
15u
15m
9c
15b
15n
15c
15f2
15f3
12d1
9
15a1
15a
12d
15m
15f1
15d
15
16c
18b
16b
18a
18a3
16a
16d
16

FIG. 57

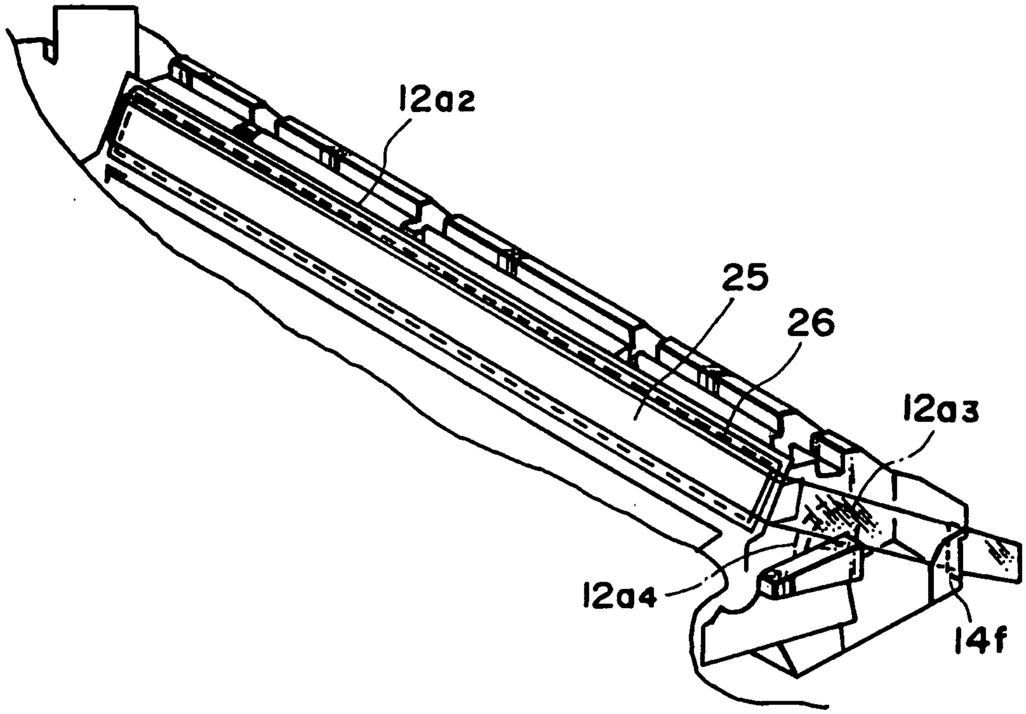


FIG. 58

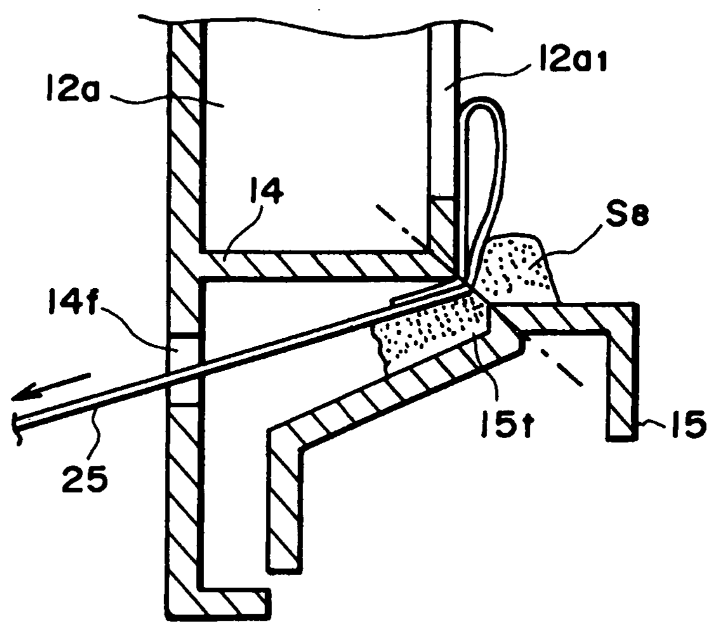


FIG. 59

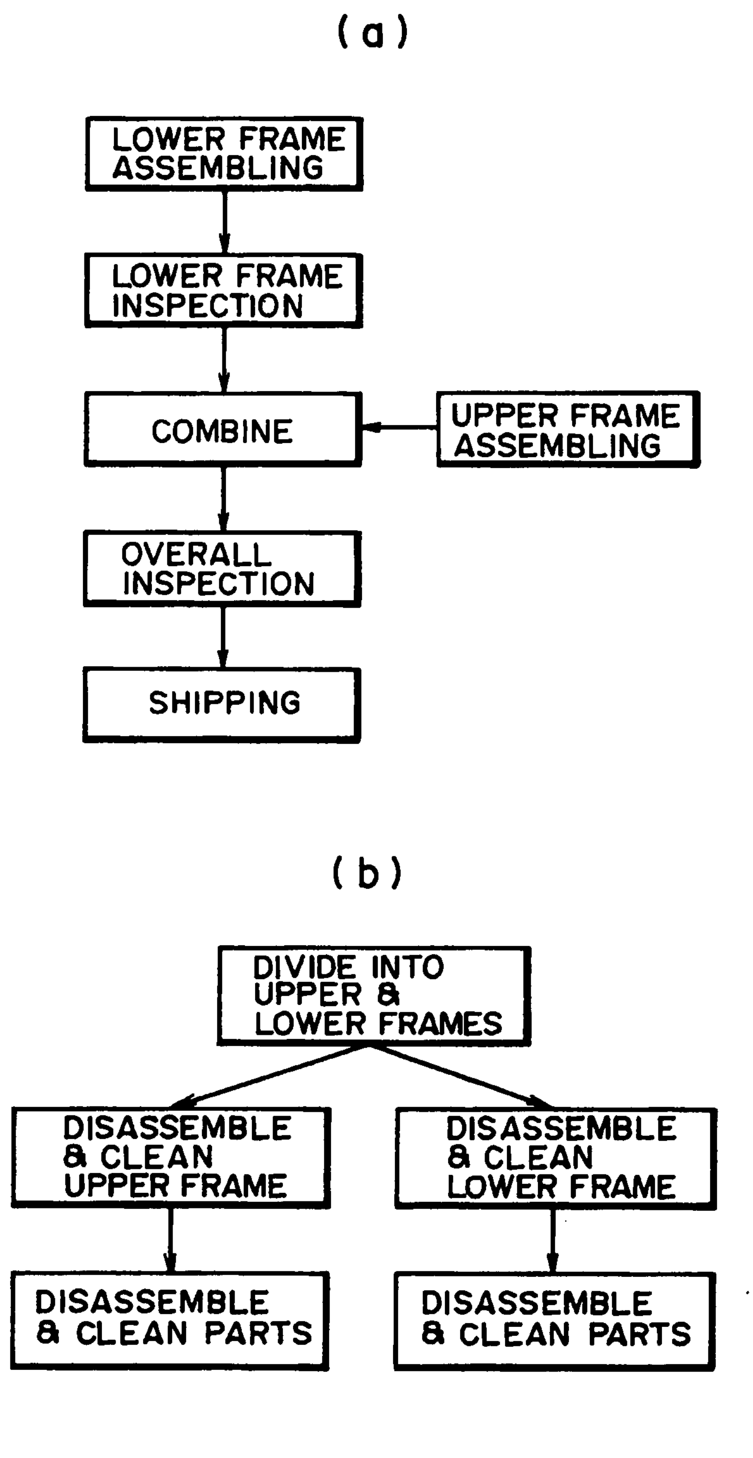

(a)
LOWER FRAME ASSEMBLING
LOWER FRAME INSPECTION
COMBINE
UPPER FRAME ASSEMBLING
OVERALL INSPECTION
SHIPPING
(b)
DIVIDE INTO UPPER & LOWER FRAMES
DISASSEMBLE & CLEAN UPPER FRAME
DISASSEMBLE & CLEAN LOWER FRAME
DISASSEMBLE & CLEAN PARTS
DISASSEMBLE & CLEAN PARTS

FIG. 60

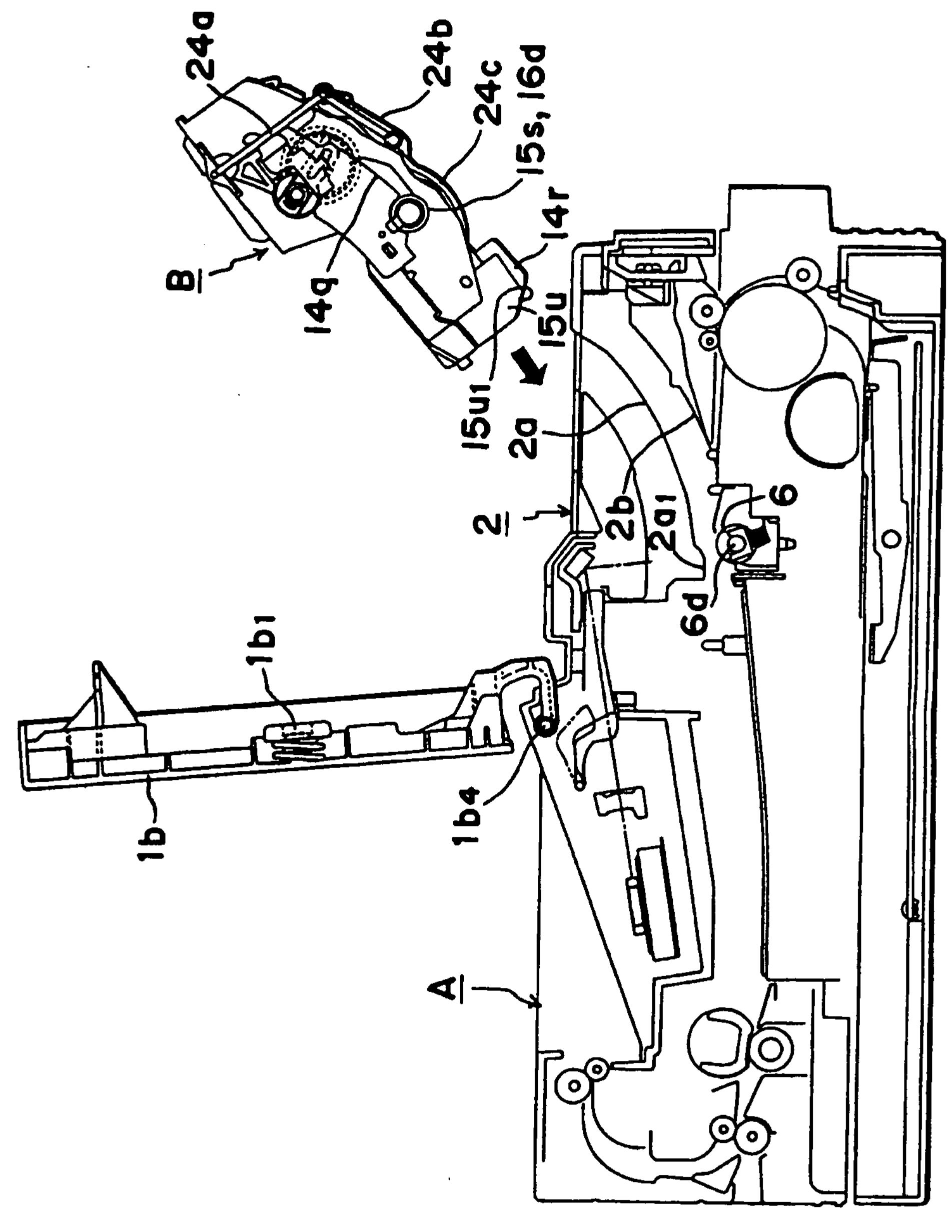


FIG. 61

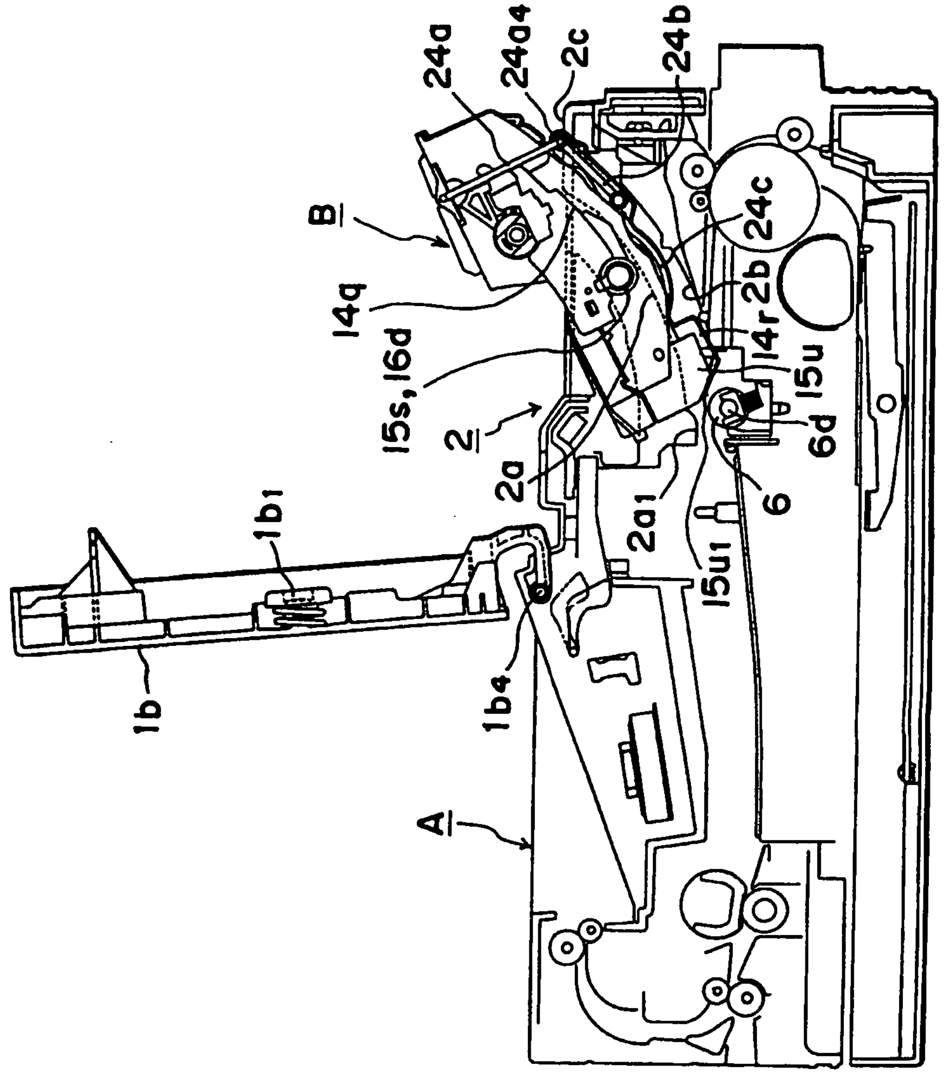

24a
24a4
2c
24b
B
24c
14q
2b
14r
15u
15s, 16d
2
6d
2a
6
2a1
1b1
15u1
1b
1b4
A

FIG. 62

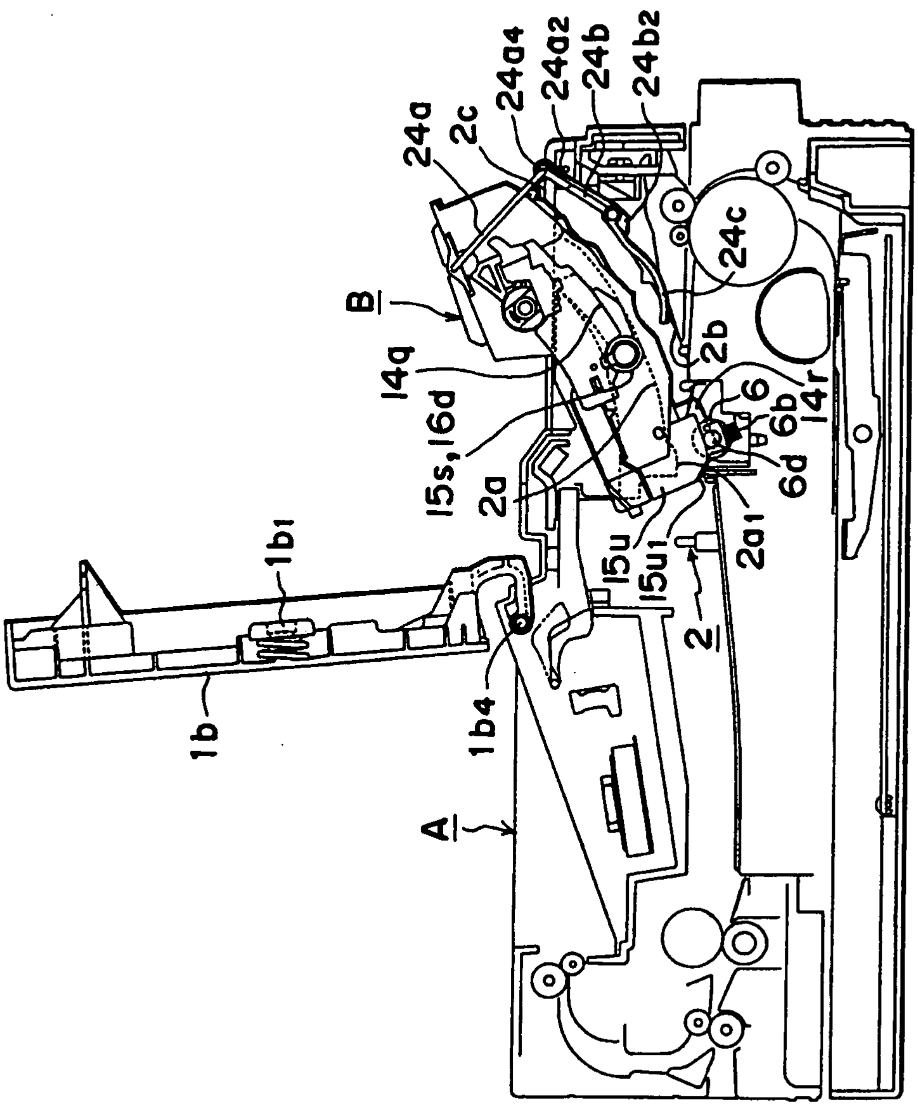
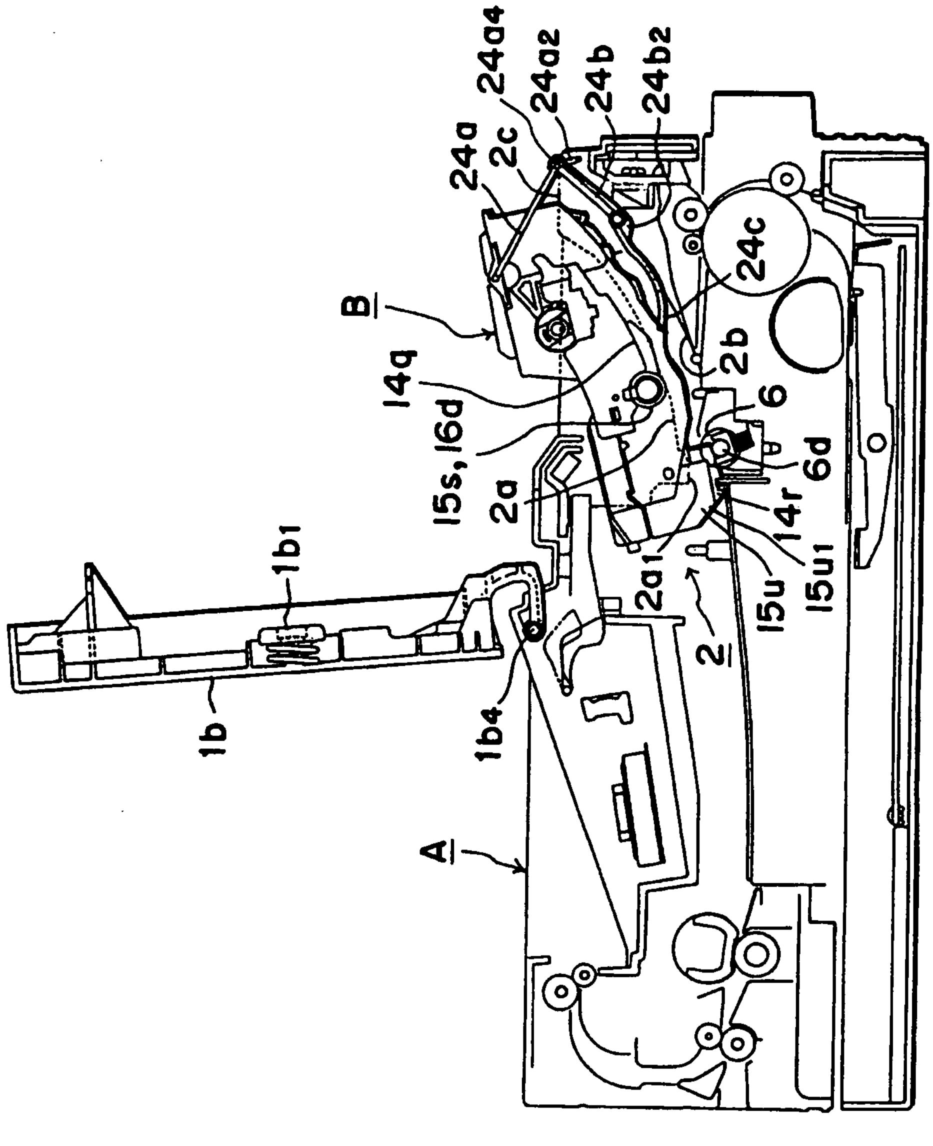

1b
1b1
1b4
A
B
2
2a
2a1
15u
15u1
15s,16d
14q
24a
2c
24a4
24a2
24b
24b2
24c
2b
14r
6
6b
6d

FIG. 63



A
B
1b
1b1
1b4
2
2a
2a1
2b
2c
6
6d
14q
14r
15s, 16d
15u
15u1
24a
24a2
24a4
24b
24b2
24c

FIG. 64

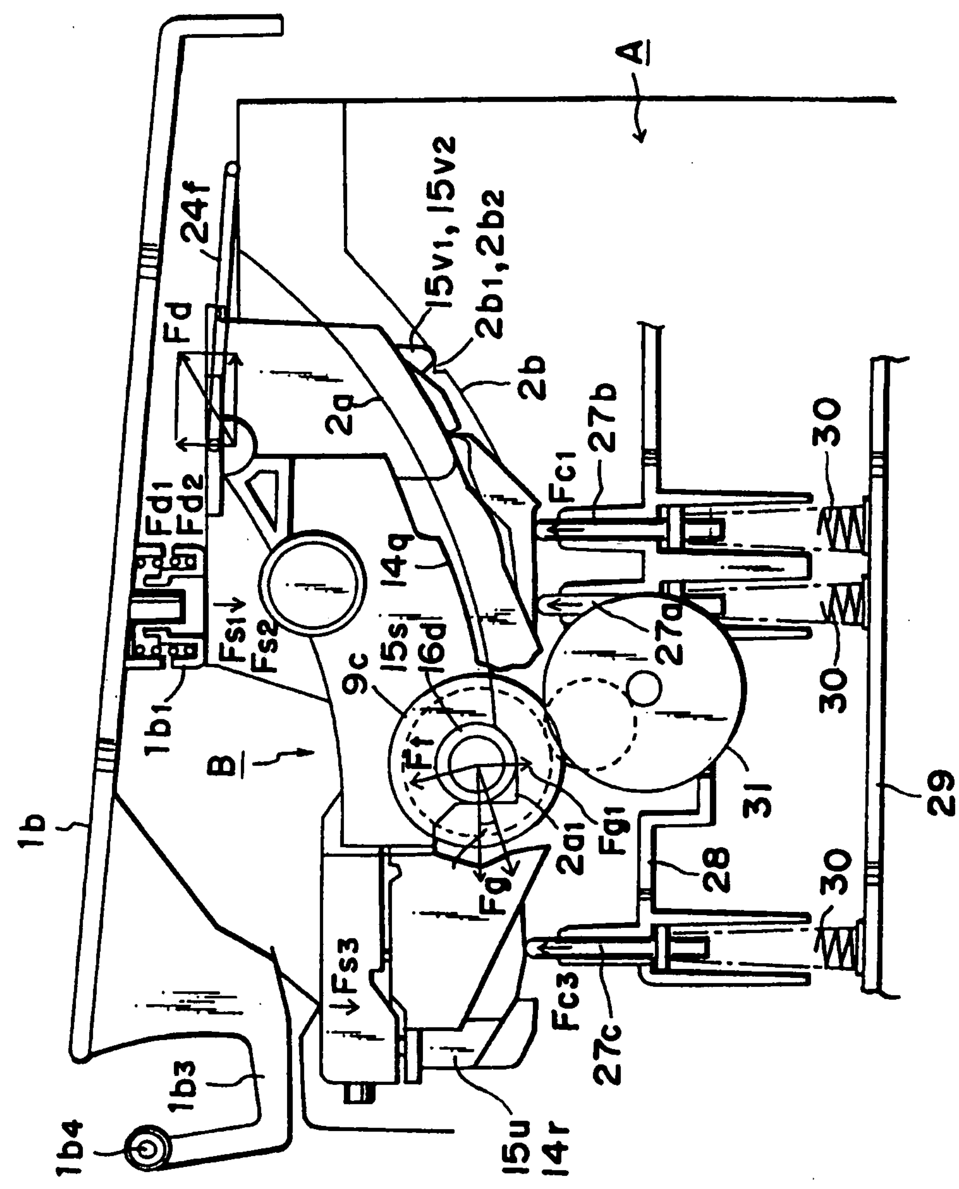

1b
1b4
1b3
1b1
B
Fd1
Fd2
Fs1
Fs2
Fs3
24f
Fd
15v1, 15v2
2b1, 2b2
2b
2a
14a
15s
16d
9c
Ft
2a1
Fg1
Fg
Fc1
27b
27a
30
31
28
29
Fc3
27c
15u
14r
A

FIG. 65

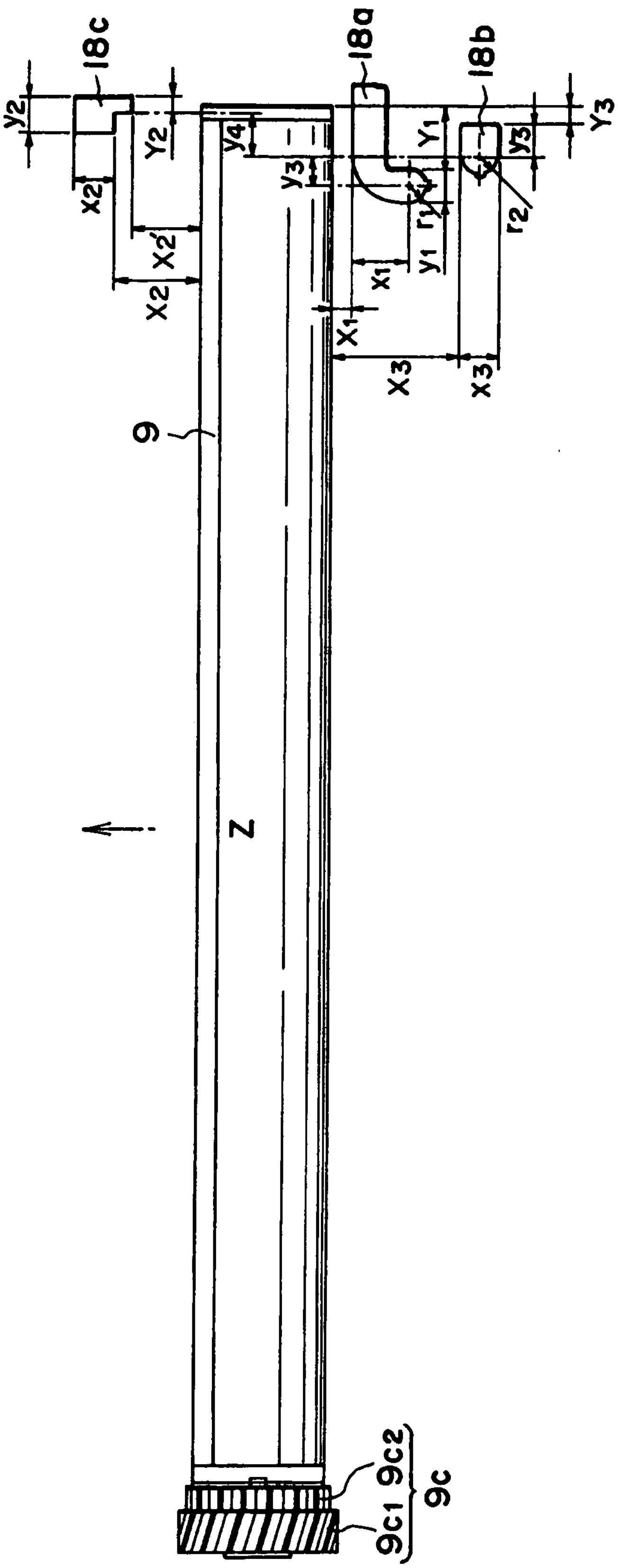

18c
18a
18b
y2
Y2
y4
y3
Y1
y3
Y3
x2
X2'
X2
x1
y1
r1
r2
X1
X3
x3
9
Z
9c1
9c2
9c

FIG. 66

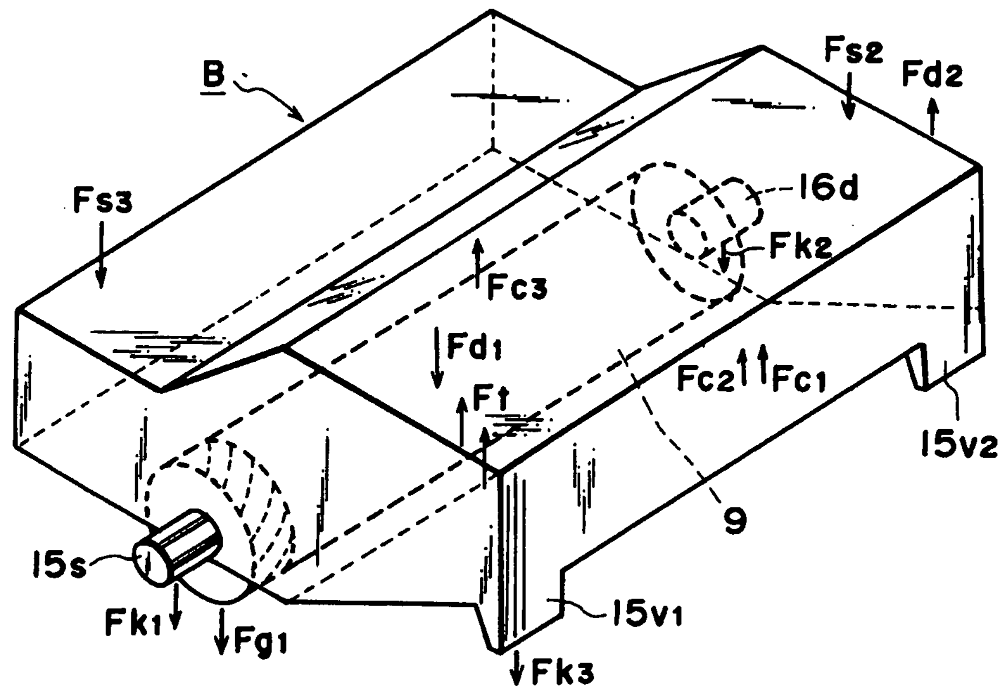

B
Fs2
Fd2
Fs3
16d
Fk2
Fc3
Fd1
Fc2
Fc1
Ft
15v2
9
15s
Fk1
Fg1
15v1
Fk3

FIG. 67

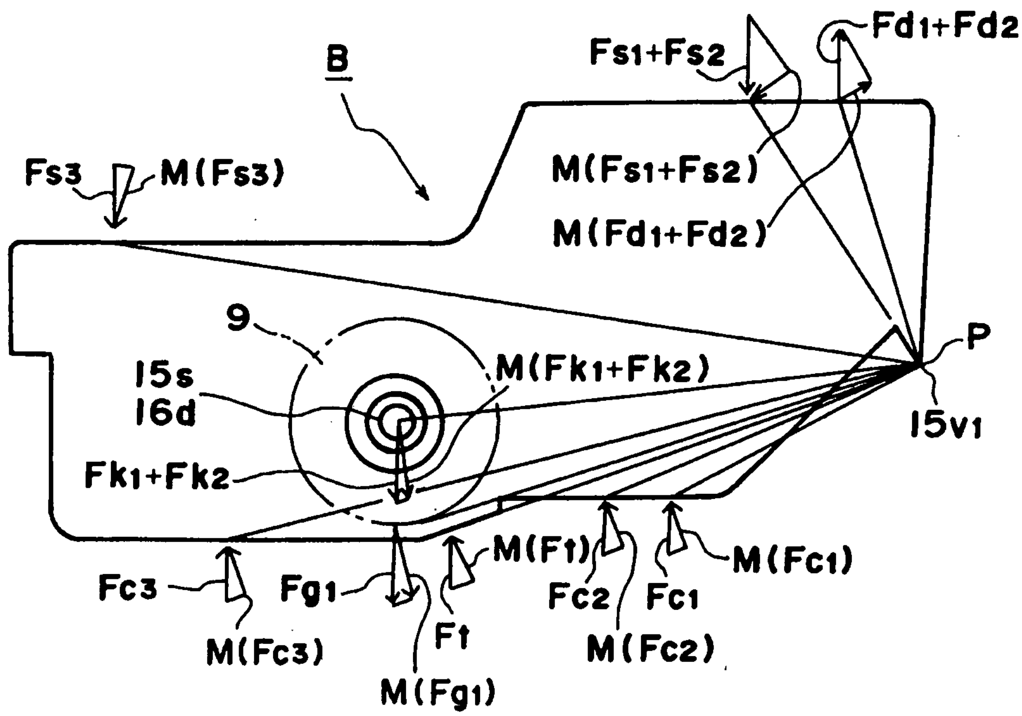

Fs1+Fs2
Fd1+Fd2
B
Fs3
M(Fs3)
M(Fs1+Fs2)
M(Fd1+Fd2)
9
P
15s
16d
M(Fk1+Fk2)
15v1
Fk1+Fk2
M(Ft)
M(Fc1)
Fc3
Fg1
Fc2
Fc1
M(Fc3)
Ft
M(Fc2)
M(Fg1)

FIG. 68

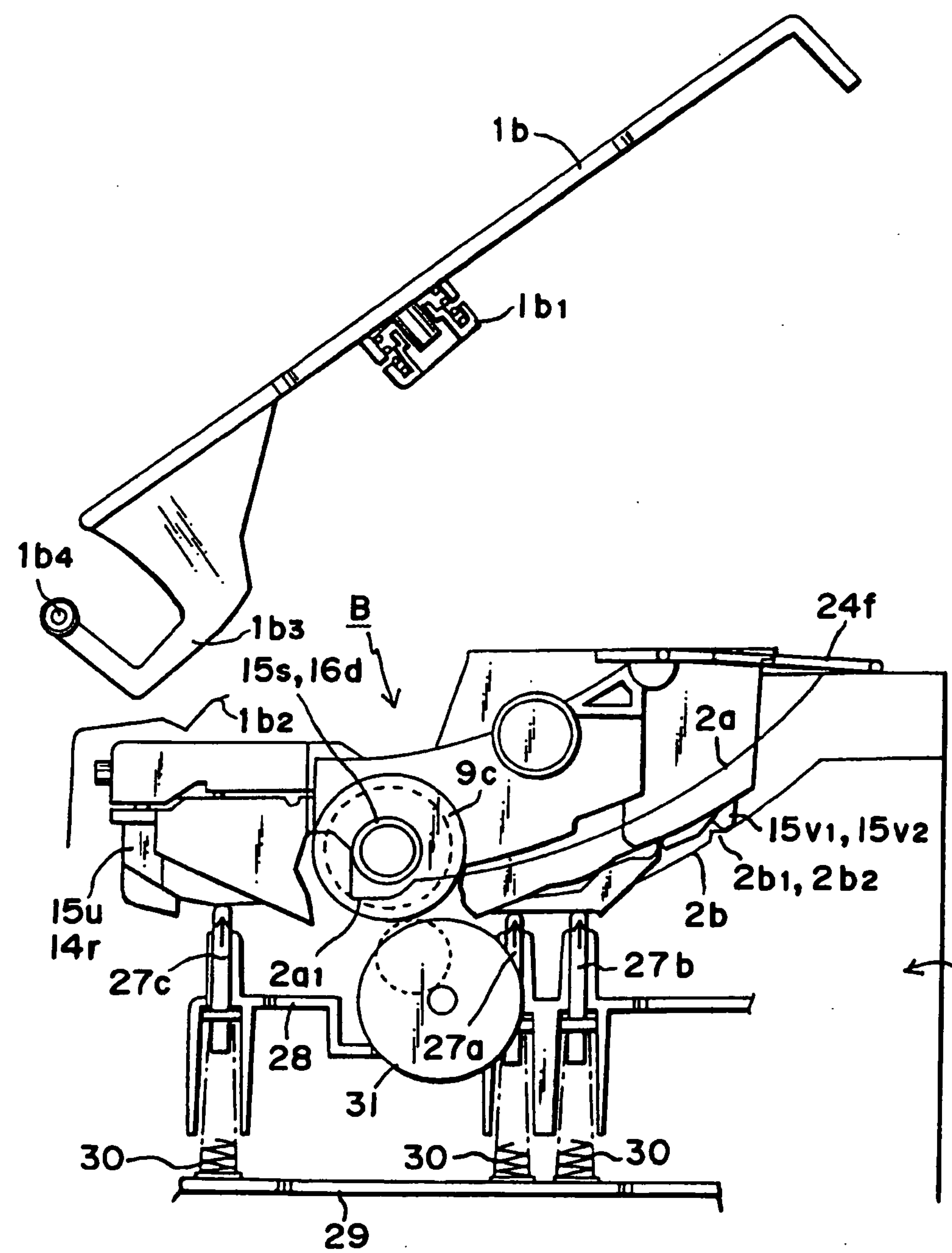

1b
1b1
1b4
1b3
B
15s, 16d
1b2
24f
2a
9c
15v1, 15v2
2b1, 2b2
15u
14r
2b
27c
2a1
27b
A
28
27a
31
30
30
30
29

FIG. 69

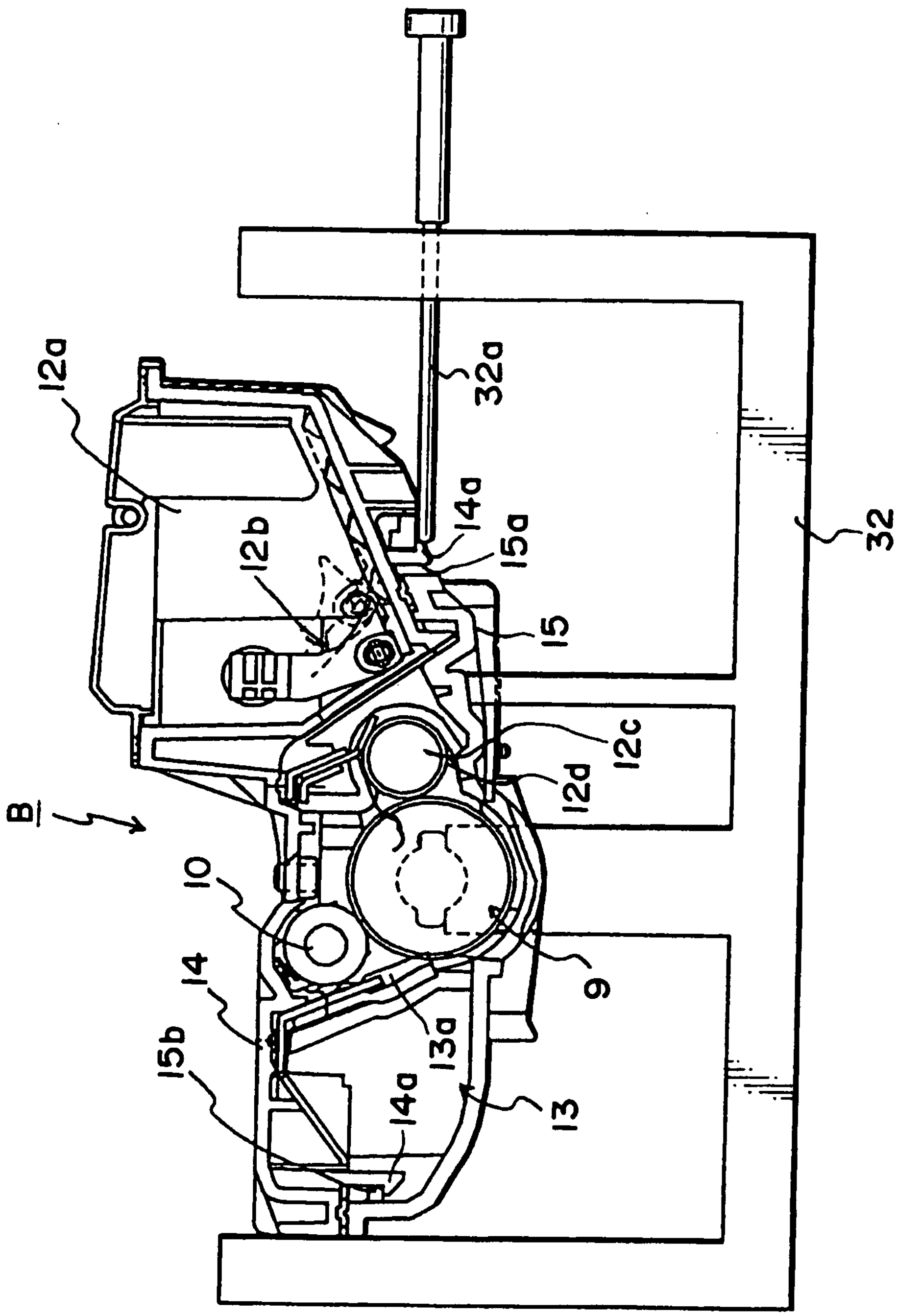


FIG. 70

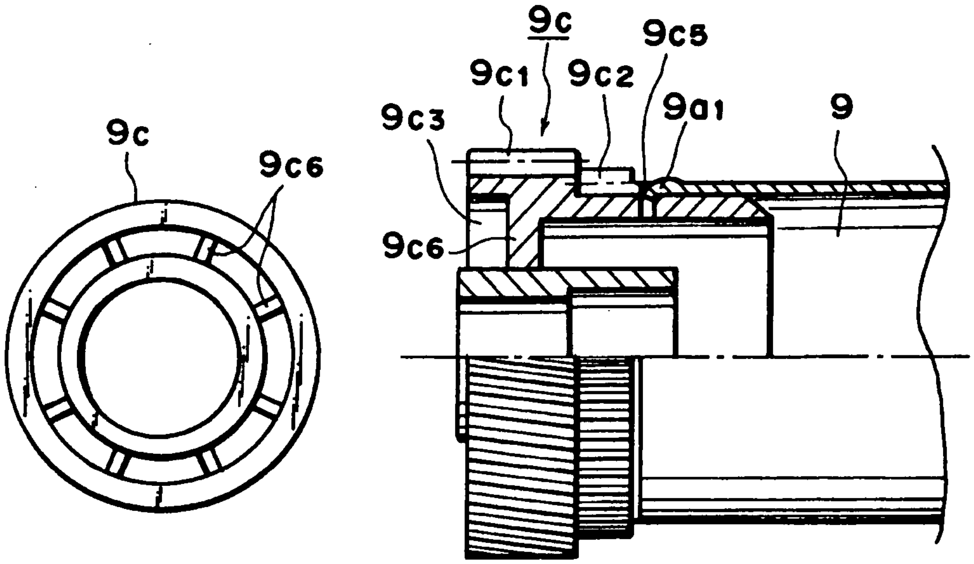

9c
9c6
9c
9c1
9c2
9c5
9c3
9a1
9
9c6

FIG. 71

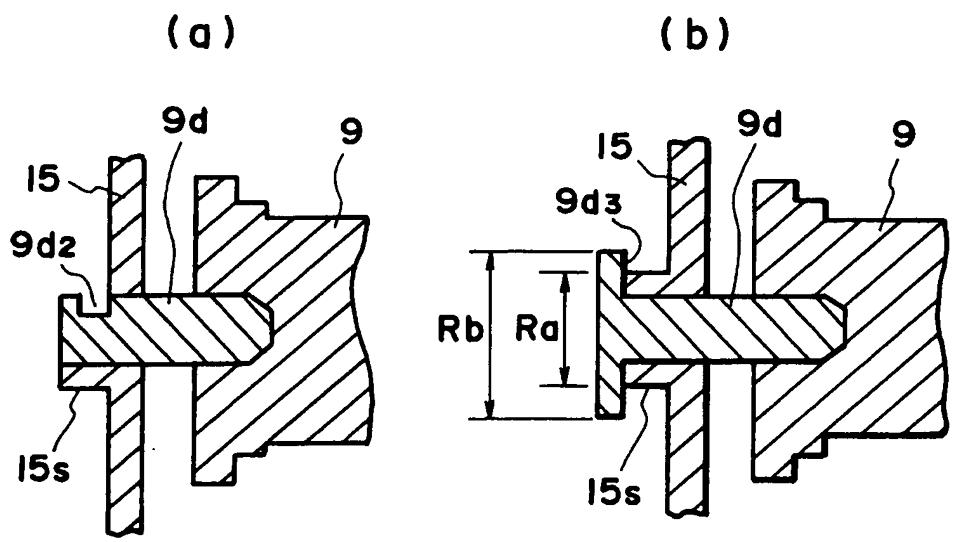

(a)
(b)
9d
9
15
9d2
15s
15
9d
9
9d3
Rb
Ra
15s

FIG. 72

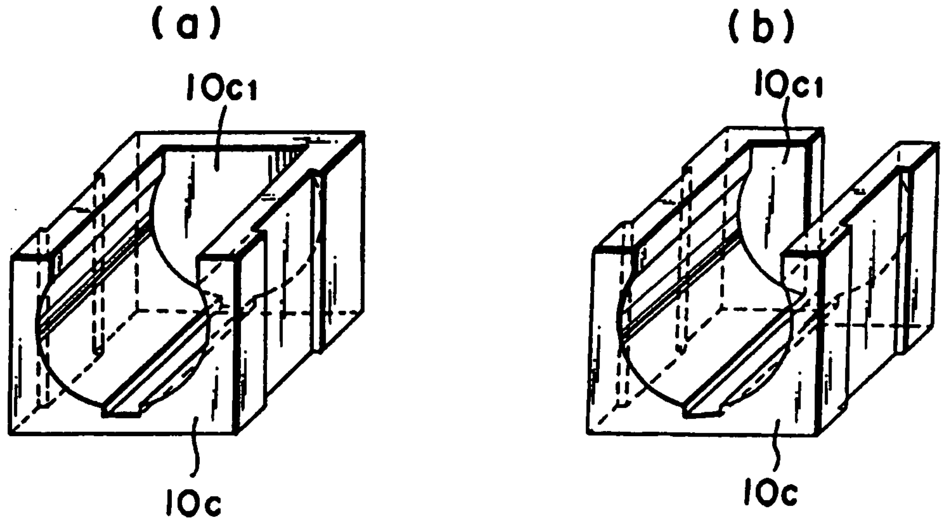


FIG. 73

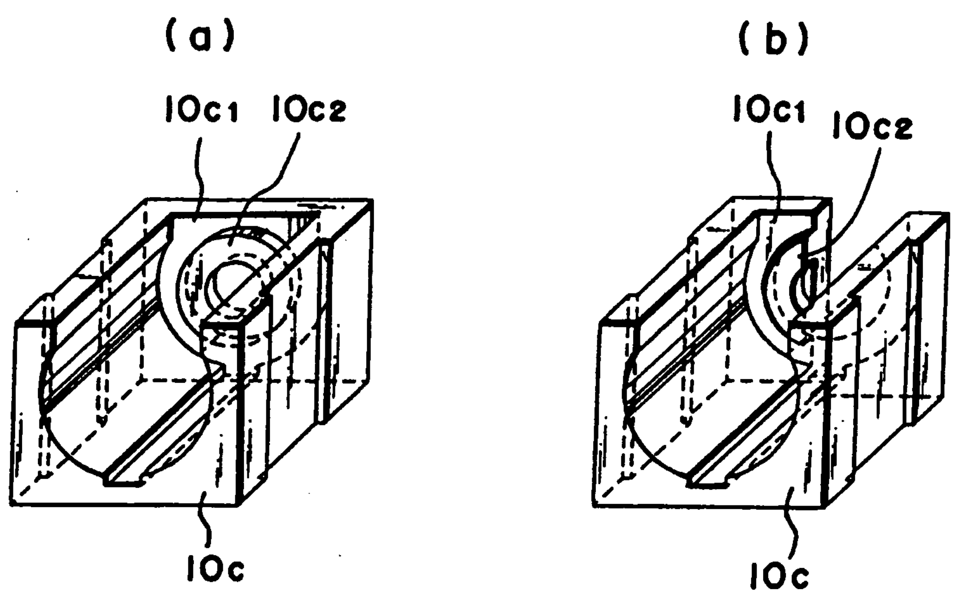


FIG. 74

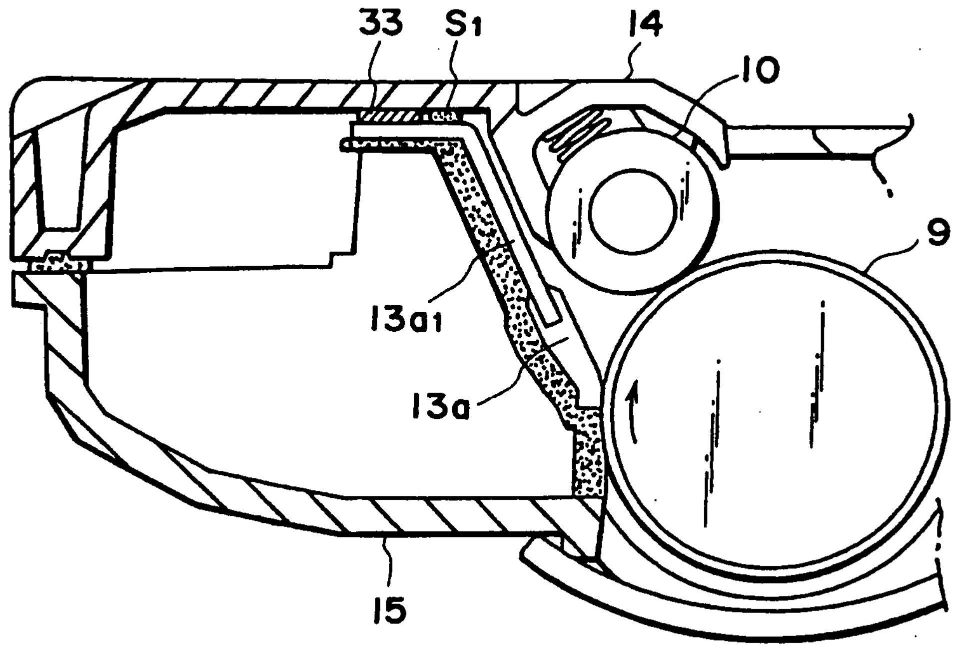


FIG. 75

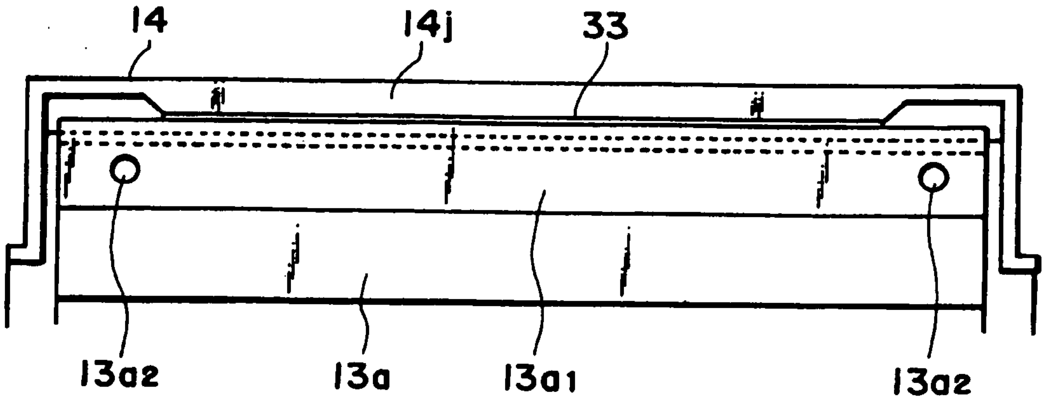

14
14j
33
13a2
13a
13a1
13a2

FIG. 76

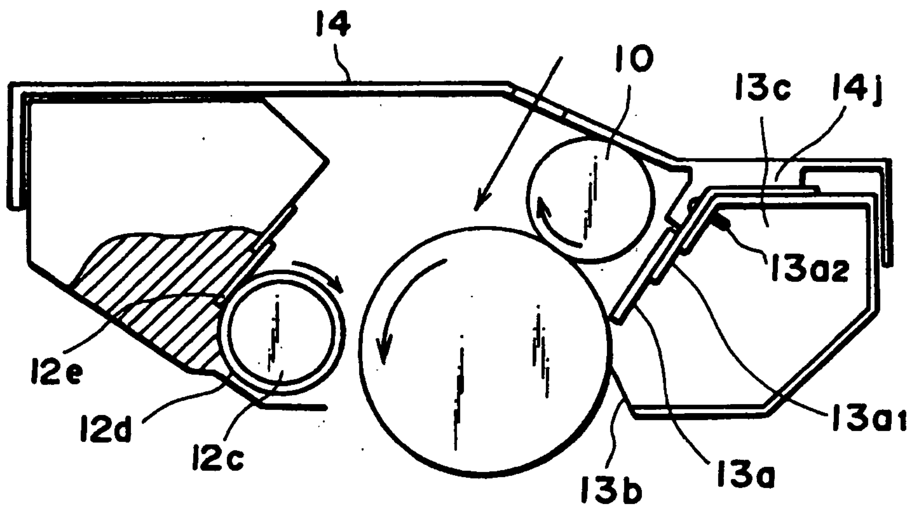

14
10
13c
14j
13a2
12e
13a1
12d
12c
13b
13a

FIG. 78

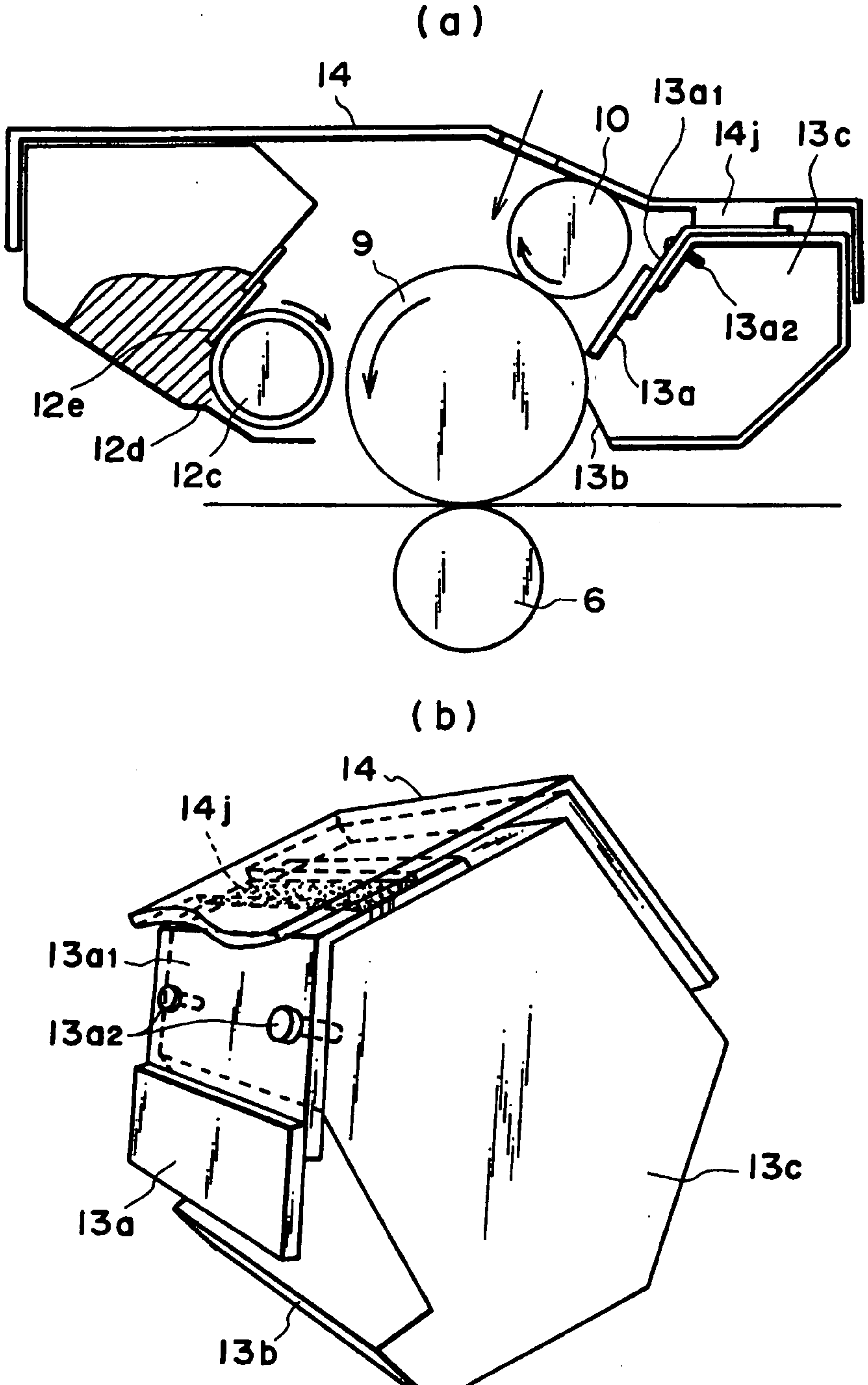
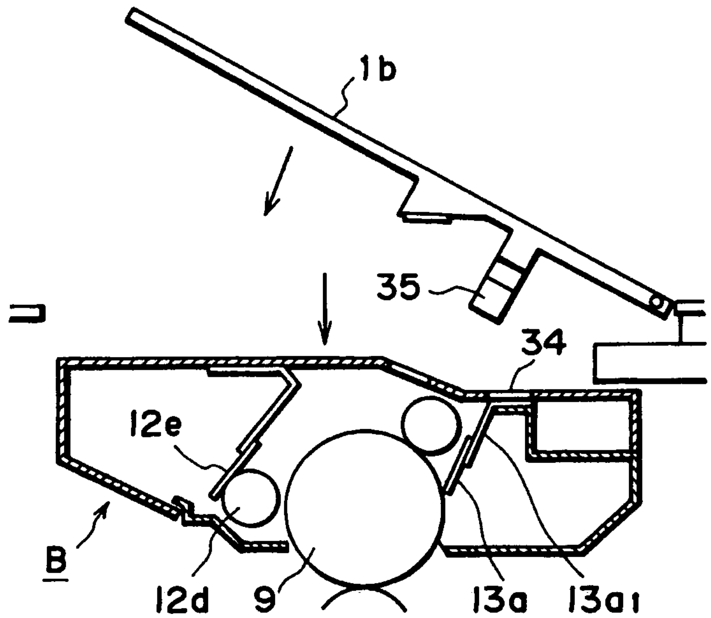

(a)
14
13a1
10
14j
13c
9
13a2
13a
12e
12d
12c
13b
6
(b)
14
14j
13a1
13a2
13a
13c
13b

FIG. 77

(a)



(b)

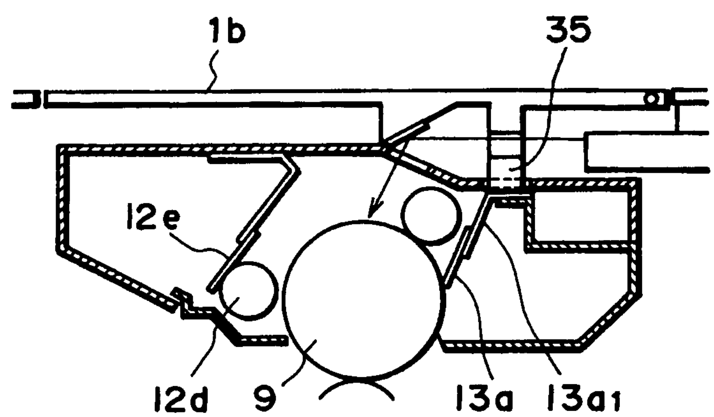


FIG. 79

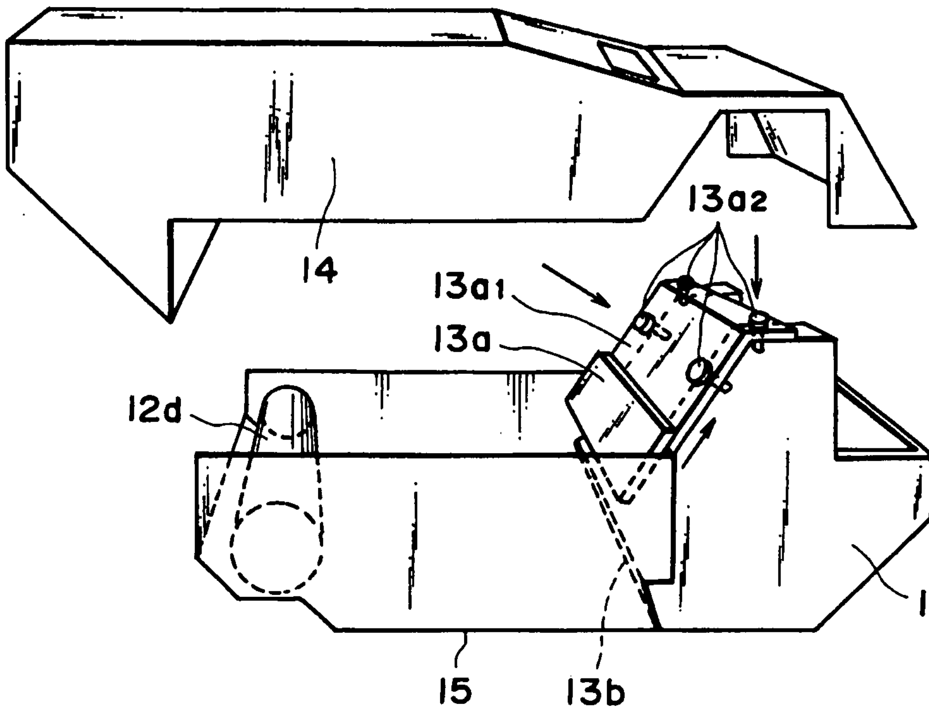


FIG. 80

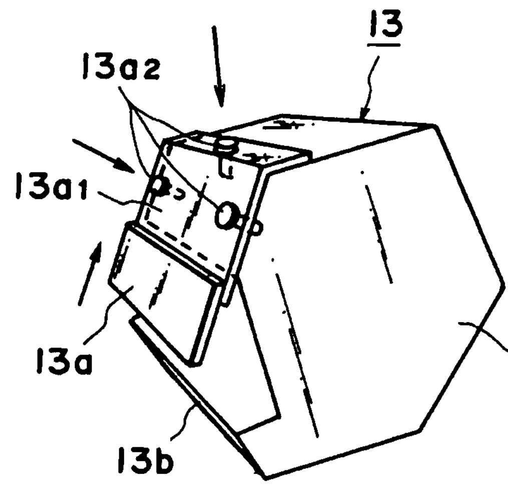


FIG. 81

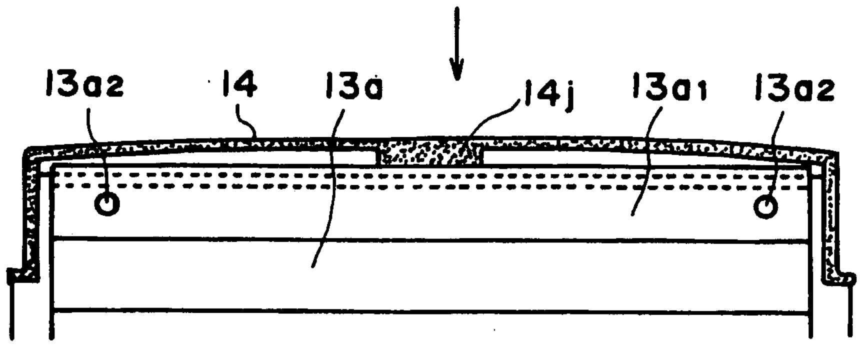
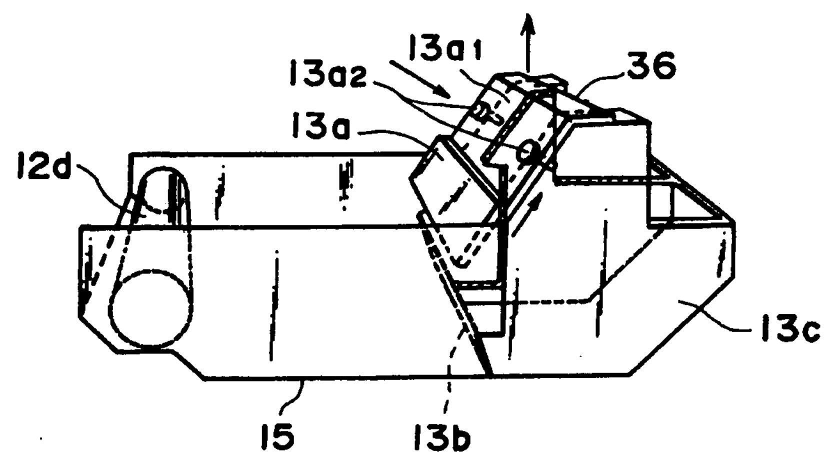


FIG. 82

(a)



(b)

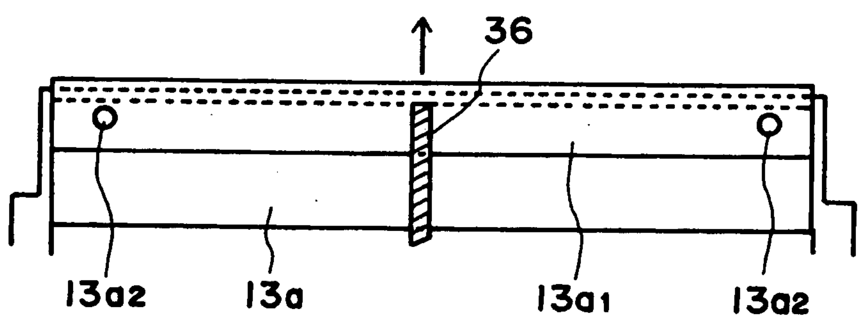


FIG. 83

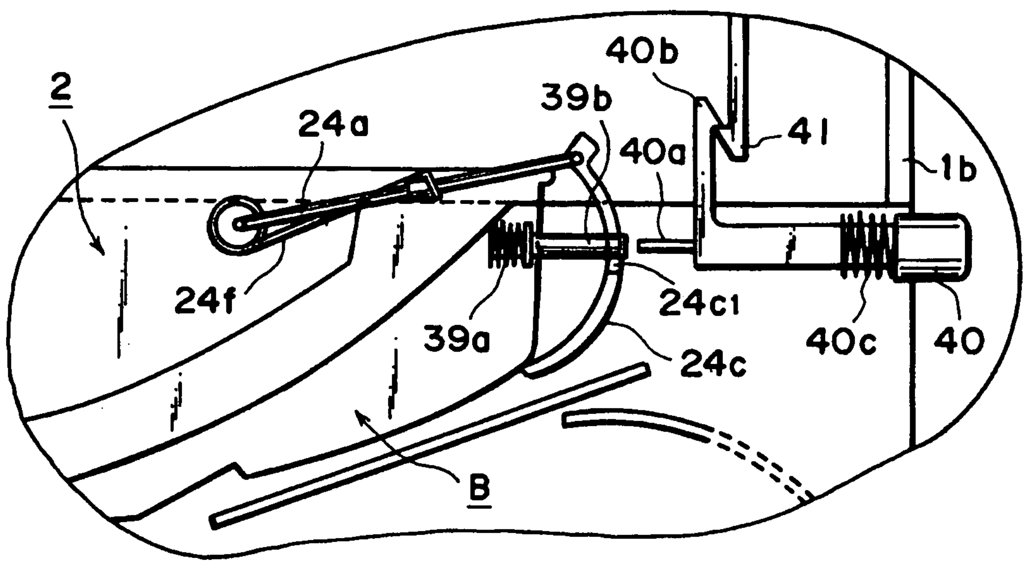


FIG. 84

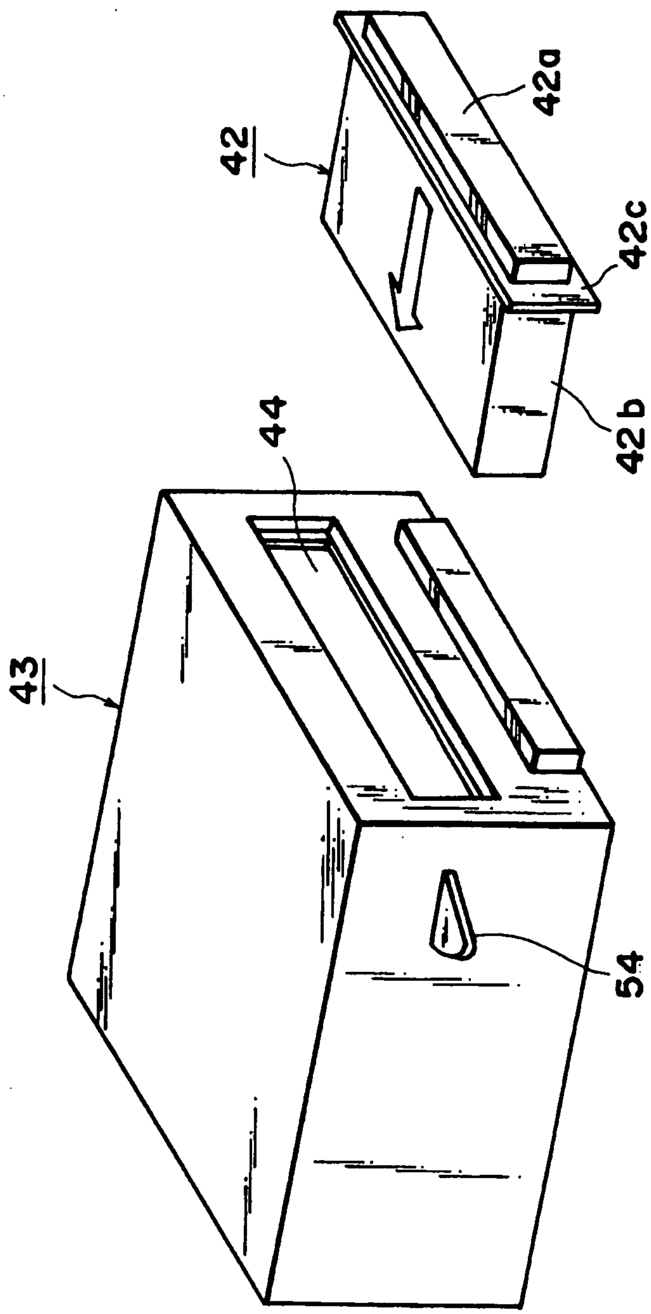


FIG. 85

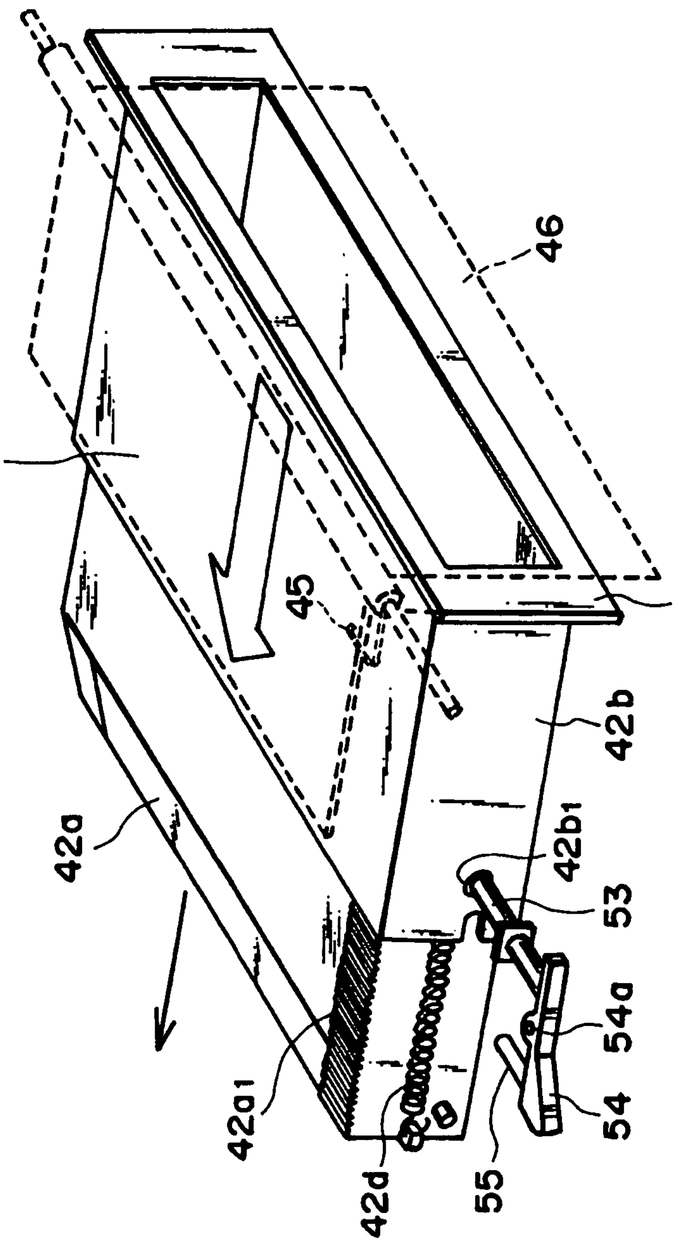
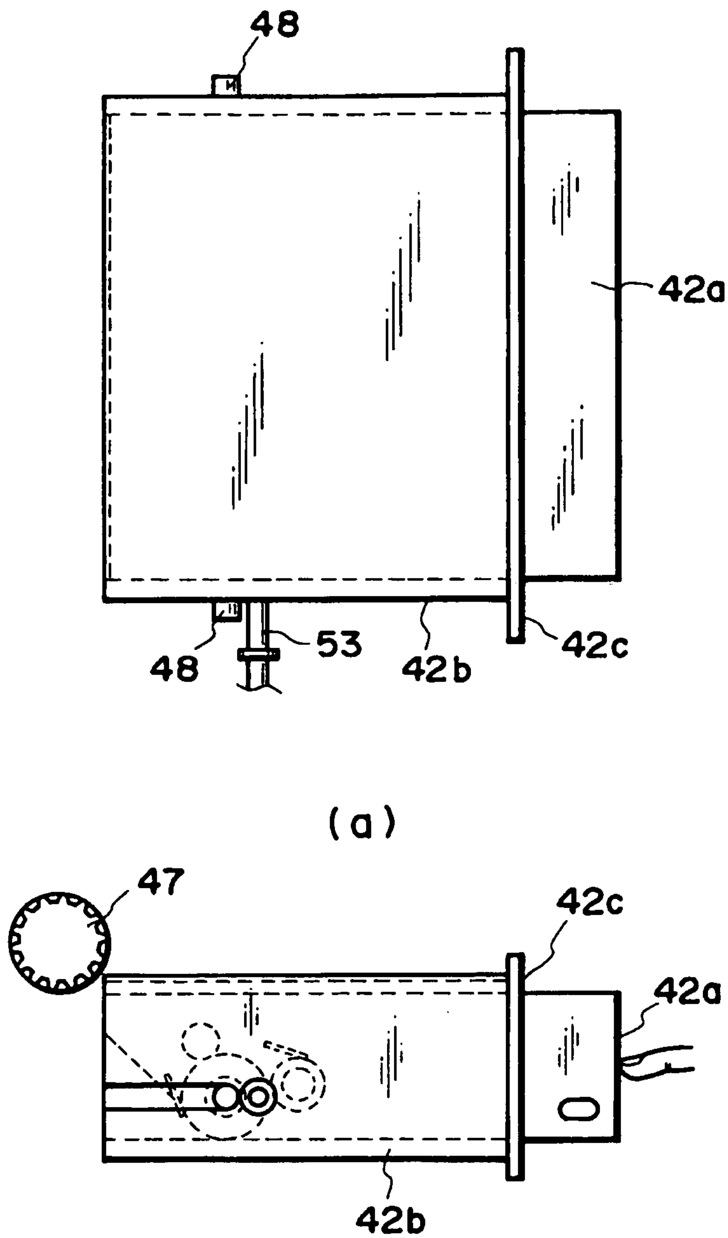


FIG. 86

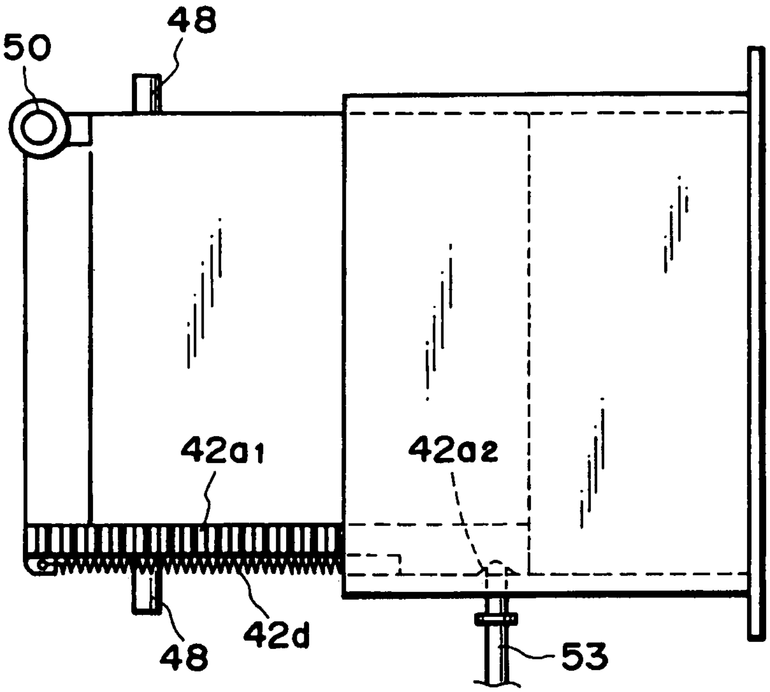
(b)



(a)

FIG. 87

(b)



(a)

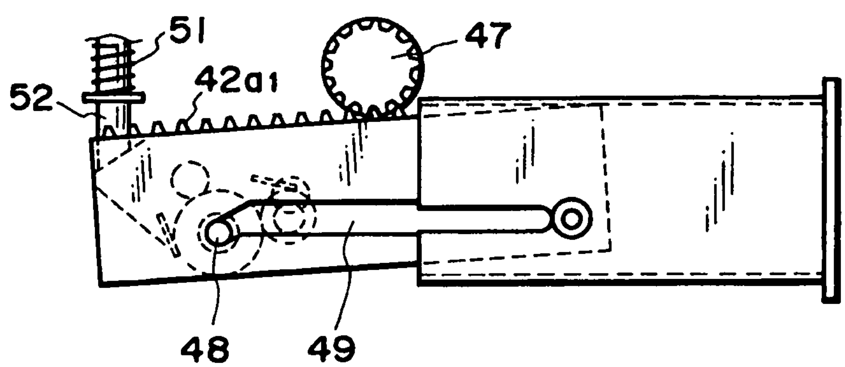


FIG. 88

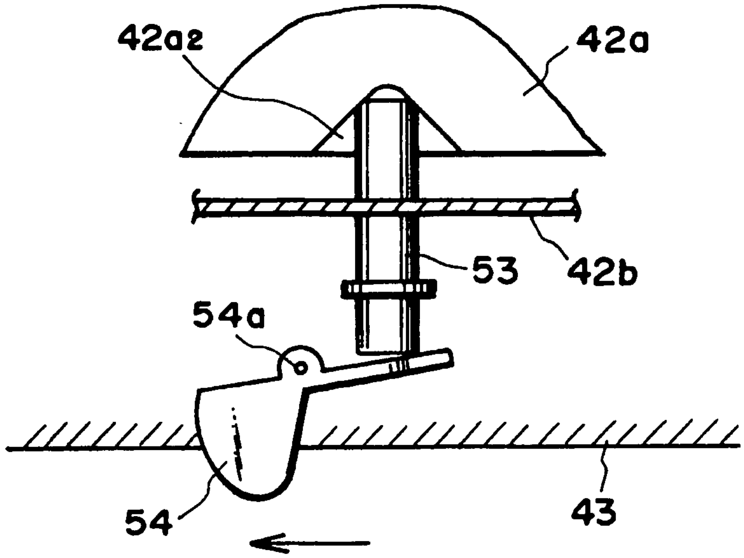


FIG. 89

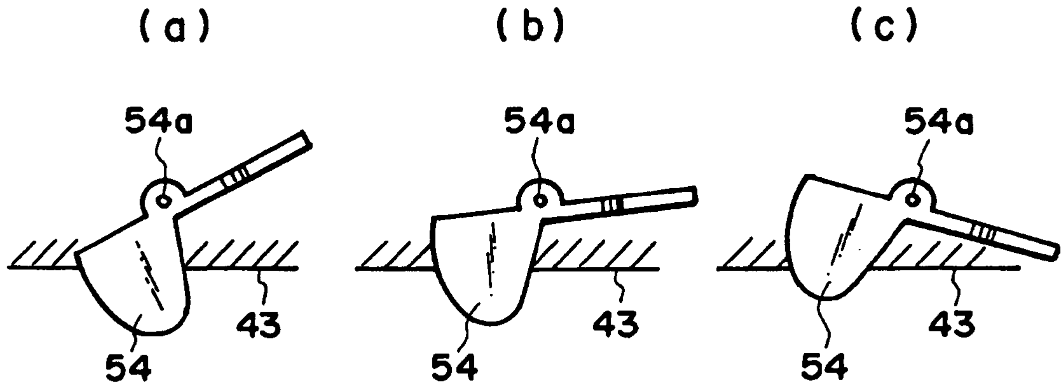


FIG. 90